Participatory Mapping of the Natural Domain and Ecological and Hydrologic Survey in Selected Communities of Tinglayan, Kalinga

A REPORT TO THE RUFFORD SMALL GRANTS FOUNDATION

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EXECUTIVE SUMMARY

The *Participatory Mapping and Ecological and Hydrologic Survey of Selected Communities in Tinglayan, Kalinga* is a research project that was started in early 2007 and was motivated partly by reports of on-going negotiations for mining exploration in portions of Tinglayan and its neighboring municipalities, and the possible construction of a geothermal plant within the said area. Tinglayan is a municipality in Kalinga whose terrestrial and inland water areas of biological importance are categorized as "extremely high" by the Philippine Biodiversity Conservation Priority-setting Program (PBCPP, 2002). The resources in this municipality, however, have never been systematically studied and surveyed.

The general objectives of the study were to survey the geological and biological resources in the area and to generate resource maps based on the field data. It is an initial documentation of the natural resources in Tulgao West and Tulgao East, two of the communities that will be affected by the proposed mining exploration and operations of a geothermal plant. Results are meant to help these communities make informed decisions regarding development projects that could potentially impact negatively on the resources that they have protected and conserved for generations. The resulting database could also help the people plan for alternative development projects that are low-impact and can be directly managed and controlled by them.

In terms of policy, this is UP Baguio's contribution to the enrichment of the Free, Prior and Informed Consent (FPIC) process, the conduct of which has been contentious from the point of view of the affected communities and other interested parties. The research output, though preliminary, is an important contribution in environmental benchmark data generation and monitoring in the Cordillera region.

Like in many places in the Cordillera region, the primary threat to the biodiversity of Tulgao's forests is land conversion. The research site was heavily disturbed by human activity (e.g. clearing of forests to give way to vegetable gardens) resulting to forest gaps of variable sizes. However, even with the fragmentation that was observed in the area, and despite the limited scope covered in the survey, the results of this study indicate a rich and diverse ecosystem.

This study may be seen as an initial Environmental and Social Impact Assessment (ESIA) that can immediately be used by the Tulgao communities, relevant agencies and government bodies to decide on whether a geothermal project should be implemented in the area.

The study concludes that safeguarding the integrity of the ecosystem in Tinglayan requires (1) the conduct of a biodiversity study in a bigger area and to include two montane forests, namely Mt. Mosimus and Mt. Binulauan, and (2) the initiation of community members in environmental monitoring. A select group of residents (barangay leaders, teachers, high school or college students, for example) can be identified and trained as local researchers to measure environmental data, like rainfall, water temperature, water discharge; properly collect flora and fauna and undertake mapping. These are doable strategies considering the success of the strategy of sustained community participation employed in this just-concluded project.

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ACKNOWLEDGEMENT

This project would not have been completed successfully if not for the partnership of the University of the Philippines Baguio team and the communities of Tulgao West led by Barangay Captain Joseph Olao and Tulgao East under the leadership of Barangay Captain Miguel Guyang. Also, various institutions and individuals supported this project and their contributions are hereby acknowledged:

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INTRODUCTION

Environmental benchmark data generation, banking and monitoring in the Cordillera and Northern Luzon is a major research thrust for the College of Science of UP Baguio. This thrust is a reflection of the unit's commitment to be of continuing service to the region as well as a recognition of the need for interdisciplinary approaches in biodiversity studies and programs that allow faculty and staff across disciplines, and local communities, to work together to address growing concerns about the environment.

The *Participatory Mapping and Ecological and Hydrologic Survey of Selected Communities in Tinglayan, Kalinga* is a project that falls within this research thrust. It was conceptualized in early 2007 motivated partly by media reports of on-going negotiations for the construction of a geothermal plant that would cover Tinglayan and nearby municipalities. Tinglayan is a municipality in Kalinga whose terrestrial and inland water areas of biological importance are categorized as "extremely high" (p. 28) by the Philippine Biodiversity Conservation Priority-setting Program (PBCPP, 2002). However, the PBCPP also warns that the socio-economic pressures being exerted in these areas of biological importance are "very high" (ibid., p. 42).

The project is an initial ecological survey in Tulgao West and Tulgao East, two barangays in Tinglayan that are to be affected by the proposed geothermal plant. Because of the lack of environmental data in Tinglayan, the general objective of the research is to document the biological resources in the said communities, and to come up with a research output that will help the people make informed decisions about the geothermal plant (regardless of what the outcome of the negotiations might be) and other future development projects in their areas. With the endorsement of local government officials in Tinglayan at the barangay and municipal levels, the research project was pursued by an interdisciplinary team from UP Baguio, composed of faculty and researchers from the College of Science and the Cordillera Studies Center.

There are two general objectives of the study, namely to survey the geological and biological resources in the area and to generate resource maps based on the field data.

Specific Objectives of the Study

1. To collate existing literature on the ancestral land, forest and water resources in Tulgao West and Tulgao East;

2. To survey, identify and catalog representative species of flora (trees, weeds, grasses, ferns and other vascular plants); terrestrial species of fauna (mammals and birds); and terrestrial and aquatic species of bacteria;

3. To describe the geophysical features of Tulgao; and

4. To generate land use resource and domain maps using geoinformation systems.

Significance of the Study

The study is an initial documentation of the natural resources in Tulgao West and Tulgao East, two of the communities that will be affected by the proposed operations of the geothermal plant. The research output, though preliminary, is an important contribution in environmental benchmark data generation and monitoring in the Cordillera region, especially in an area that has never been systematically studied.

The research also provides the Tulgao people with useful information about their environment and resources so that they are well aware of what are at stake when making decisions not only on the proposed geothermal plant but on other modernization projects that might be proposed or implemented in the area. Our assumption is that the people will be better prepared in coming up with an informed position regarding the entry of modernization/development programs and projects in their areas, if they have in their possession a variety of data and information that might help them in their decision-making.

The resulting database could also help the people plan for alternative development projects that have low-impact and can be directly managed and controlled by the community. In terms of policy, this is UP Baguio’s contribution to the enrichment of the Free, Prior and Informed Consent (FPIC) process, the conduct of which has been contentious from the point of view of the affected communities and other interested parties.

A Note on the FPIC Process

In March 2007, a Free, Prior and Informed Consent (FPIC) process was held in areas that will be affected by the pre-operation activities of the geothermal plant. These would include well drillings and geothermal explorations for seven (7) years.

The proposed site for the drilling operations in Tinglayan covers 400 hectares, directly over and below the people's swidden farms, rice fields and residential houses. It is part of an important communal forest in Tulgao and nearby communities that has never been systematically studied. The FPIC is an important process that seeks to ensure that people in target sites of modernization/development projects are consulted and involved in decision-making. Also an integral part in the whole process is the conduct of an Environmental and Social Impact Assessment (ESIA). Unfortunately, it has been observed that having ESIAs have failed to protect the environment adequately (Doyle, Wicks and Nally, 2007). Affected communities and several non-government organizations that are actively monitoring such processes question the integrity of ESIAs because these are conducted by the DENR and the companies themselves, instead of independent bodies who do not have a stake on the project. They also noted the non-compliance of the guideline which stipulates the conduct of an ESIA before the FPIC process is initiated. In practice, these are done after the company has already obtained the consent of the people. The government has also successfully pushed for an amendment in the process, allowing for the simultaneous conduct of both the FPIC and the ESIA (ibid, v.; CPA, 2006).

These gaps in the FPIC process, as well as in the conduct of ESIAs in relation to mining operations in the country have been noted in the report of a fact finding mission to the Philippines, entitled Mining in the Philippines: Concerns and Conflicts (Doyle, et. al., 2007). Members of the fact finding team reported the "difficulty communities had in obtaining copies of ESIAs, of the lack of independent analysis or explanation of their contents and implications" (ibid, p. 12), and on how companies comply with environmental standards.

Two of their recommendations for immediate action by the Philippine government are (1) provision for independent technical … advice and support to communities and indigenous peoples … in both the FPIC and ESIA processes and where licenses are granted, throughout the life of the projects; and (2) the conduct of Strategic Environmental Appraisals (SEAs) to identify threats to biodiversity and sustainable development, including protected sites as well as sacred sites of indigenous peoples. Thus, the SEAs would help "identify current and all potential threats and their accumulative impacts" (ibid, p. 12).

SEAs should not be confused with the ESIA. These are two different studies that may be done independently by different groups. The proposal is to have the environmental appraisal before the FPIC, while the conduct of the ESIA should be done regularly in relation to the operations of the project.

THE RESEARCH SITE

Physical Characteristics

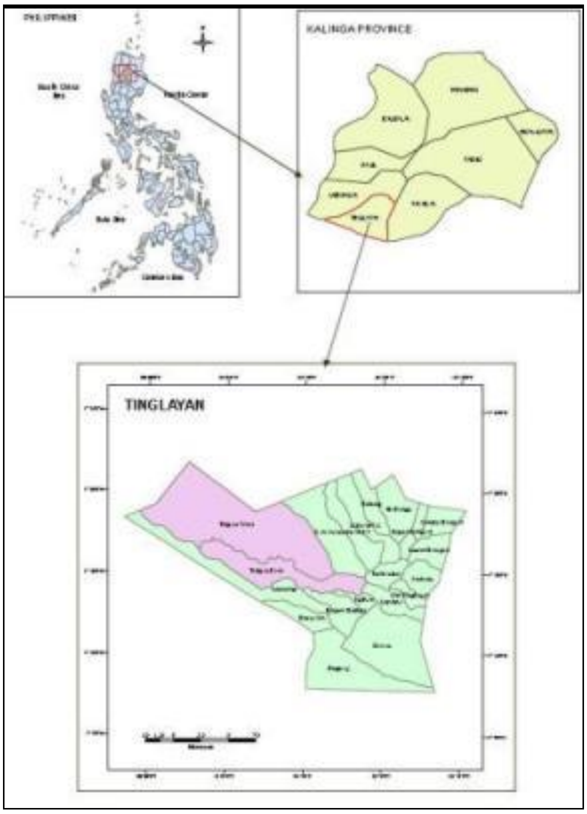
The municipality of Tinglayan is roughly 170 kilometers from Baguio City. It is the first Kalinga municipality coming from Mt. Province, bounded by Sadanga and Bontoc, Mountain Province in the south, Tubo, Abra in the southwest, and the Kalinga municipalities of Lubuagan (north) and Tanudan (east). It is composed of twenty (20) barangays with an area of 326.8 sq. kilometers (or 32,679.94 hectares). This comprises 10.32% of the total land area of Kalinga province (Comprehensive Land Use Plan (CLUP) of Tinglayan, 2004).

The research sites Tulgao West and Tulgao East are the westernmost barangays of the Municipality of Tinglayan in the south of the Province of Kalinga. A 2000 survey shows Tulgao West as having the biggest land area in the province at 81.74 sq. kilometers. The second biggest, barangay Basao, only has 35.49 sq. kilometers, while Tulgao East is fourth with land area covering 25.65 sq. kilometers. Together, Tulgao West and East cover 107.39 sq. kilometers or 32.9% of the total land area of the province.

Tulgao (used here to refer to both West and East) is bounded by approximate coordinates 17_{o}15’ to 17_{o}21 north latitude and 120_{o}56’ to 121_{o}07’ east longitude. It is situated on the eastern flank of the Cordillera Central Mountain Range, an anticline whose northeast trending summit here marks the approximate western limit of the study area.

Like the rest of Northern Luzon, Tulgao is subject to the northeast trade winds from November to March and the southwest trade winds from June to October. Climate is generally wet, with annual rainfall exceeding 2500 mm. Like in other parts of the country, rainfall is especially heavy from June to November. Tulgao can be reached through fair weather roads.

Figure 1: Maps of Tinglayan Municipality and Kalinga Province



REVIEW OF RELATED LITERATURE

The Philippines is one of the island constellations of Wallacea. Wallacea originated primarily as island arcs at pressure points between sliding ocean plates in the Pacific. These tectonic forces have caused geologic uplift and volcanism. Wallacea is one segment of specific biogeographic regions in Asia which were studied by Russell Wallace, a contemporary of Charles Darwin.

In 2005, Heaney, Walsh & Peterson stated that “The Philippine archipelago is an exceptional theatre in which to investigate the roles of past history and current ecology in structuring geographic variation. According to them, the Philippines is an area of high biotic diversity and exceptional endemism that is in critical need of conservation, citing others who shared their view, among them Myers (1988), the Wildlife Conservation Society of the Philippines (1997), Heaney & Regalado (1998), Mittermeier *et al* (1999), Holloway (2003), and Mey (2003).

Alcala (1998) in his Introduction of the Vanishing Treasures of the Philippine Rainforest, stated that the number of plant and animal species in the Philippine rain forest is incompletely known. According to him, there are an estimated 13,500 plant species, of which about 8,000 are flowering plants. Of these, about 3,200 are endemic. Philippine land vertebrate species number about a thousand, with approximately 80 amphibians, some 240 reptiles, 556 birds (resident and migratory), and 174 mammals.

Remarkable Diversity of Philippine Fauna

Each oceanic island that has remained continuously isolated from its neighboring islands is a unique centre of mammalian endemism, with 25–80% of the nonvolant mammals endemic, even on islands of only a few hundred square kilometers. Similar patterns are evident among butterflies (Holloway, 2003) and trichopteran insects (Mey, 2003).

The terrestrial mammalian fauna of the Philippines has been traditionally divided into four major provinces based, on richness, composition and degree of endemism (Heaney and Rabor. 1982). These are the Palawan group of islands, the Mindanao Province, the Luzon Province, and the Panay-Negros Province. The Luzon province reportedly contains fewer families, but those present, especially the Muridae, have radiated into a wide variety of niches, and many endemic genera are present (Taylor, 1934).

The mammalian fauna of the region is remarkably diverse. According to Heaney (1985), there are in the country at least 17 endemic genera of rodents, two of insectivores and four of bats, as well as many endemic species of widespread genera.

New species are still being discovered in the region. Alcala (1998) reports having described eight new species of forest frogs in a space of five years. He cites the work of Heaney and his colleagues that reported 16 new mammal species during the last ten years. According to Alcala, it is the exceptionally high level of endemism that is now attracting international attention, with figures that are found nowhere else in the world: seventy-five percent of the amphibians, 70 percent of reptiles, 44 percent of birds, and 64 percent of mammals. He echoes Heaney's belief that Philippine mammals have the highest percentage of species endemism in the world on a hectare-for-hectare basis, which could be true for other groups as well.

Also in 1998, Heaney wrote that "while it is noteworthy that at least 111 of the 170 native species of terrestrial mammals (64%) are endemic (Heaney *et al*, 1998), it is still more striking that 24 of 84 genera (29%) are endemic, implying much *in situ* diversification, and phylogenetic studies suggest that several large endemic clades are present among fruit bats and murid rodents (Heaney & Rickart, 1990; Heaney, 2000; Steppan *et al*, 2003).

Before the recent intensive work done by Heaney and other foreign and Filipino taxonomists, the inventory of Philippine mammals had been badly out of date. The earliest works were by Dickerson (1928) and Taylor (1934).

Oldfield (1898) reported what he referred to as a 'remarkable series of animals' collected by Whitehead in the plateau of Monte Data (now known as Mt. Data) between 1895 and 1897. In 1992, Bibby stated that Luzon mountains are among the nine areas in the country which have been classified as Endemic Bird Area (EBA).

A list of faunal species and their ecological status was reported at Kabugao-Conner, Kalinga-Apayao and Pinukpuk, Kalinga-Apayao by the ENR-SECAL (2004). The list includes 7 species of reptiles, 52 species of birds and 11 species of mammals. There were fifty six (56) birds recorded and observed present in the area, out of which fifty (50) were truly identified.

Economic Significance

The economic significance of the mammals was highlighted in the recent work by Stuart, et al. (2007). They recorded a diverse rodent fauna in Banaue Ifugao rice terraces, including the non-native pest species, *Rattus anezumi*, and the native species, *Rattus everetti* and *Chrotomys mindorensis*. Results from trapping and spool-and-line tracking suggested that these native species do not contribute to rice damage and that several may actually be beneficial in the rice field ecosystem as vermivores that feed on invertebrate pests. Control should therefore be directed at the pest species, *R. tanezumi*, minimizing non-target effects on the non-pest rodent species.

The birds economic value was attributed to their predatory characteristics. They feed on insects, which are harmful to plants, thus keeping the insect population in balance. Being a fruit feeder, they aid in seed dispersal and pollination. Some of these birds can be considered as species with aesthetic value because of their beautiful and colorful plumage.

Addressing Threats of Biodiversity Loss and Extinction

Deforestation in the Philippines is the most rapid and most severe in the world, with only 20% of forest cover remaining. According to Sajise (1985), the Philippines needs at least 54% forest cover to regulate its natural processes. Only about 1.87 million hectares, about 6 percent, have remained as prime habitats of wildlife. The immediate reasons for the drastic reduction of the primary forest area are large-scale logging and conversion to agriculture, and are strongly associated with the rapid increase in human population, reaching about 70 million in 1997. Over 15 million upland people today threaten the survival of the remaining forests, despite government effort at protection.

According to Alcala (1998), the Philippines may now be classified a hotspot owing to a large number of endemic species in tropical rain forest, including the forest itself, that are now threatened with complete destruction. Already some 52 native vertebrate species are in the critical or endangered categories, and a great many more are listed as threatened like the frog *Platymantis spelaeus* and the fruit bat *Dobsonia rabori*. Another frog, a bushy-tailed cloud rat, and at least one species of bird are probably extinct as well. According to him, most endemic land vertebrates (including birds, small arboreal frogs, and many mammals) require primary-forest habitats and fail to survive in highly disturbed and secondary forests.

Preservation of the primary rain forest is therefore a high priority for the Filipino people.

Heaney (1986) said that modern conservation biology has two fundamental goals: (1) preservation of natural communities that are representative of the biotic regions of the world; and (2) prevention of extinction of species. In 1991, he wrote, “Habitat preservation is the most common requirement for the conservation of all the species mentioned. However, other factors must be considered as well in developing plans for the conservation of the fauna: the impact of commercial trade, the impact of subsistence hunting, and the current limits of knowledge of the distribution and diversity of the fauna.

In a study on montane forest diversity and land use in Paoay, Benguet and Mount Data, Austria, Co & Romero (1999) asserted that the overall impact of biodiversity loss in their study areas and in many parts of the Cordillera requires more thorough ecological and policy studies, taking into consideration indigenous knowledge systems.

The Soil as Habitat

The soil is a complex habitat for microbial growth. It is a heterogeneous medium of solid, liquid and gaseous phases that vary in properties across varying landscapes and depth. In addition there is competition that exists among a variety of organisms for nutrients, space and moisture. Typical microorganisms found in soil are bacteria, actinomycetes and fungi as well as other living forms like animals and plant roots (Wollum, 1999.)

Bacteria are prokaryotic, single celled microorganisms that inhabit soils throughout the world. They are extremely diverse and versatile metabolically. They can transform soil minerals and organic matter from one form to another and alter the availability of essential nutrients such as nitrogen, sulfur, carbon and phosphorus for plants and other soil organisms to use. Therefore bacteria play central roles in organic matter decomposition, nutrient cycling and soil formation (Alexander, 1999).

Another organism found abundant in soil are the fungi, a group of diverse, multicellular, eukaryotic organisms. They are plant like since they contain cell walls, they are generally non-motile and reproduce by means of spores. The vegetative body of the fungus is called a thallus, and it generally exists as either yeast cells or the mycelia. Yeast cells are spherical to oval cells that divide by budding or fission, while mycelia is a filamentous network of hyphae that branch and grow by apical extension. Fungi inhabit almost any niche containing organic substrates, and their primary role would be degraders of organic matter. They are also agents of diseases, agents of soil aggregation and an important food source for humans and many other organisms (Morton, 1999).

Other microbial organisms found in soil are the algae, protozoa and viruses that are also major players in the important processes that build soil. These organisms vary greatly in morphology, physiology, reproduction and habitat.

Soil Microbial diversity

Soil microorganisms play a significant role in maintaining soil quality especially in agriculturally managed systems and these microbes are highly influenced by environmental factors. Microbial soil characteristics are indicative of changes in resource availability, soil structure, pollution and it may represent the key to understanding the impacts of environmental and anthropogenic factors. Soil microbial diversity can represent the ability of a certain soil to cope with environmental disturbances and it has been proposed by soil microbiologists to be an indicator of soil quality. It is important therefore to study the soil microbial diversity and soil community structures when monitoring environmental influences on soil quality (Hartmann and Widmer, 2006).

Soil microbiologists often describe soil microbial communities as among the most complex, diverse, and important assemblages in the biosphere. Because of such high-level diversity**,** soil microbial communities are among the most difficult to phenotypically and genetically characterize. To study soil microbial community diversity, molecular techniques are often used like small-subunit (SSU) rRNA gene analyses and (rDNA)-based cloning and sequencing approaches. More studies of a variety of soil types and habitats are needed to obtain a more comprehensive view of microbial community diversity and structure in soil environments (Zhou et al., 2004). Classical microbiological methods like cultivation based techniques are insufficient for studying the diversity of naturally occurring prokaryotic communities because the majority of bacteria are believed to be unculturable by these traditional techniques (Amman et al., 1995). This is the main reason why most studies on microbial soil diversity would use the molecular approach like 16S rDNA gene sequences to avoid the limitation of culturability and to be able to analyze a larger potion of the bacterial community in soil samples (Prieme et al., 2002).

However there are studies that would use both the conventional and molecular methods. The study of Smit et al. (2001) used both methods to analyze bacterial diversity in a wheat field in the Netherlands to compare data obtained by cultivation-based methods with data found using molecular techniques, to investigate the magnitude of seasonal changes in the bacterial community, and to use the data to search for general ecological relationships. In their study, soil samples were taken in the different seasons over a 1-year period. Fatty acid-based typing of bacterial isolates obtained via traditional plating methods revealed a diverse community of mainly gram-positive bacteria, and only a few isolates appeared to belong to the *Proteobacteria* and green sulfur bacteria. Some genera, such as *Micrococcus*, *Arthrobacter*, and *Corynebacterium* were detected throughout the year, while *Bacillus* was found only in July. Isolate diversity was lowest in July, and the most abundant species, *Arthrobacter oxydans*, and members of the genus *Pseudomonas* were found in reduced numbers in July. Analysis by molecular techniques showed that diversity of cloned 16S ribosomal DNA (rDNA) sequences was greater than the diversity among cultured isolate.

Moreover a study done by Ellis and co authors (2003) used both the culture independent and culture dependent traditional methods in examining the bacterial community structure in a heavy metal contaminated site. Results of their study indicated that metal contamination did not have a significant effect on the total genetic diversity present but affected physiological status, so that the number of bacteria capable of responding to laboratory culture and their taxonomic distribution were altered. Thus, it appears that plate counts may be a more appropriate method for determining the effect of heavy metals on soil bacteria than culture independent approaches.

A similar study was done by Chien et al., (2008) wherein they used molecular methods to study bacterial diversity in a soil sample from a site next to a chemical industrial factory previously contaminated with heavy metals. Using 16S rDNA sequence analysis using DNA extracted directly from soil, they were able to isolate 17 different bacterial types namely *Polyangium* spp., *Sphingomonas* spp., *Variovorax* spp., *Hafina* spp., *Clostridia*, *Acidobacteria,* the enterics and some uncultured strains. In addition, microbes able to tolerate high concentrations of cadmium (500 micromol/L and above) were also isolated from the soil. These isolates included strains of *Acinetobacter*, *Enterobacter* sp. and a strain of *Stenotrophomonas* sp. The results indicated that the species identified from direct analysis of 16S rDNA of the soil can be quite different from those strains obtained from enrichment cultures and the microbial activities for heavy metal resistance might be more appropriately addressed by the actual isolates.

Bacterial community structures are difficult to study because of their magnitude in number, the typical size is 10^9 cells per gram of soil using the traditional plate count method, while based on DNA reassociation kinetics the estimated number of distinct genomes present in a gram of soil ranges from 2,000 to 18,000 (Dunbar, 2002). Factors that affect microbial diversity could vary depending on the type of soil studied. For instance, agricultural land may be affected by the rhizosphere. Rhizosphere as defined by Hiltner (1904) (as cited by Wollum, 1994) as the portion of the soil that is under the immediate influence of the plant root. Generally microorganisms are found in greater numbers and diversity in the rhizosphere compared with nonrhizosphere locations. As Wollum (1994) further explained, differences may be due to root exudates, alteration of the partial pressures of O_2-CO_2, coupled with changes in nutrient availability that may be controlled by acidity, plant acidity, plant species, stage growth or moisture stress. Generally most microbiologists recognize that the number of microbes per unit volume decreases as the reference point moves away from the root.

Moreover, soil structure depends on the association between mineral soil particles like sand, silt, clay and organic matter in which aggregates of different size and stability are formed. A study undertaken by Sessitch et al., (2001) analyzed the topsoil samples of different fertilizer treatments of a long term field experiment by separating the samples by pore size and using molecular methods, they characterized the microbial community structure. Results revealed that the microbial community structure was significantly affected by particle size, yielding higher diversity of microbes in small size fractions than in coarse size fractions. They attributed the low diversities in larger size fractions to factors like low nutrient availability, protozoan grazing, and competition with fungal organisms. Furthermore, larger particle sizes were dominated by *Proteobacteria*, whereas high abundance and diversity of bacteria belonging to the *Holophaga/Acidobacterium* division were found in smaller size fractions.

Community Mapping and Participation

Mapping as a tool for analyzing local situations has a very long history. In the 1980s, nongovernment organizations and many academic researchers working with the grassroots evolved methods that allowed more involvement in mapping domains and territories. These had greatly changed and increased the intensity of community participation, from people being passive recipients of what is about to happen or what has already taken place or serving as mere providers of information, to participants that actively contributed to data generation, analysis and decision making, as well as independent initiatives for change (see Arnstein 1969 on the Ladder of Participation).

Alcorn (2000) argues that community-based maps not only allow popular participation in arenas previously dominated by the maps of governments and corporations created for development and exploitation of natural resources, they also provide a way to renew local commitment to governing local exploitation of those same resources.

Mapping can also have desirable impacts on community organizing. Older members of the community may use the process to assist them in relating and relaying legends, beliefs, rules, and practices that influence their traditional conservation practices to their younger counterparts. Alcorn (ibid, p. 4) claims that when completed, maps are proudly exhibited and "a feeling of group identity and history is affirmed". He cites other positive effects of mapping. Local people who were involved in the exercise are enriched by the experience and, more often than not, empower them for more action. Maps can be used to strengthen resource rights, to aid in planning for sustainable development, for policy change, for promoting intra-community co-operation and for reclaiming lost lands.

For these reasons, Alcorn concludes that "maps are powerful political tools in ecological and governance discussions."

Participatory GIS

Geographic Information Systems is a computer-based technology that combines geographic data, i.e. locations of man-made and natural features on the earth's surface and other types of information to generate maps. Examples of other types of information are sociodemographic characteristics, land use practices and livelihood activities. These may be stored as tables, graphs, text or even photos. Geographic information technology involves "systems to store, manage and analyze geographically referenced data (geographic information systems), devices that measure geographic location (global positioning system or GPS receivers); and airborne data collection systems that provide periodic land use, land cover and other thematic information (aerial and satellite remote sensing)" (Deichman and Wood, 2001).

The use of GIS in broad-based and public participatory processes is called Participatory Geographic Information Systems or PGIS, a method evolved from the rich and diverse experiences in participatory development (and participatory mapping). The practice of PGIS is based on using geo-spatial information management tools including sketch maps, aerial photographs, satellite imagery, Global Positioning Systems (GPS) and Geographic Information Systems to represent peoples' spatial knowledge. Such knowledge is expressed in various forms, like digital or physical, i.e. 2-or 3-dimensional maps. These materials, in turn, are used as venues for information sharing, discussion, and analysis of current situations and as support in advocacy and decision making (Rambaldi, 2004). The information gleaned from these materials can assist in the formulation of appropriate responses. Map products and their analysis are made available because of innovations present in PGIS.

Weiner (2001) argues that participatory GIS may promote the participation of community organizations in policy-making, where the state may become willing to share more power with a credible partner. Other benefits are the enhancement of the capacity to generate, manage and communicate spatial information; the perpetuation of an avenue that stimulates innovation; and ultimately, the encouragement of positive social change (Corbett, et. al., 2006).

PGIS Practice among Indigenous Peoples

Many documented applications of PGIS have illustrated achievements that clearly benefited indigenous peoples and marginalized groups. For example, Weiner and his co-authors (2001) have identified "various applications involving indigenous natural resource mapping in arctic and tropical regions within the Americas (see Marozas, 1993; Cultural Survival Quarterly, 1995). There is also a rapidly growing network of planning professionals interested in how GIS can merge with community participation in the context of neighborhood revitalization and urban planning (Aitkin and Michel, 1995; Craig and Elwood, 1998; Talen, 1999, 2000). Environmental groups are experimenting with community GIS applications to promote environmental equity and address environmental racism (Sieber, 2000; Kellog, 1999). Furthermore, NGOs, aid organizations, and governmental agencies are linking communities with geographic information systems as they seek to promote more popular and sustainable development projects (Dunn, *et al*., 1997; Elwood and Leitner, 1998; Gonzalez, 1995; Harris *et al.*, 1995; Hutchinson and Toledano, 1993; Jordan and Shrestha, 1998; Kwaku-Kyem, 1999; Mitchell, 1997; Obermeyer and Pinto, 1994; Rambaldi, G. and J. Callosa 2000; Weiner,*et al.*, 1995; Weiner and Harris, 1999).

Participatory three-dimensional mapping exercises for collaborative protected area management have been documented in the Philippines (see experiences of Mount Banahaw, Mount Isarog, Panay Island, El Nido-Taytay in Palawan) and among the Ogiek indigenous peoples who have had experiences in 3D-modelling in Kenya (Rambaldi, 2007). Participatorymapping is also useful in defending territories and ancestral domain. Such application has been exemplified by the use GIS, Google earth and remotely sensed data by Amazon tribes to protect their lands from the exploitation of developers (Butler, 2006; Hearn, 2007); and the employment of GPS in foot surveys by the Huaorani of eastern Ecuador in defending their territory from loggers and international oil companies (Hearn, 2007). The Dayak of Sarawak have likewise utilized GIS to claim their customary lands. The community mapping activity was facilitated by the Borneo Resources Institute (BRIMAS), a non-government organization aimed primarily "to delineate and document the native customary land boundary and help preserve the community's traditional knowledge to their customary land. The output was used "as a tool for negotiation and resolving disputes between the community with outside parties or within the community itself" (Bujang, 2004: page 4).

Based on documented experiences, some practical and methodological issues in undertaking community-based, GIS-aided mapping and planning have been identified including access and ownership of information, building local skills, and how to use of GIS information to support analysis and decision making.

In general, the idea behind participatory mapping exercises is to involve participants in data collection on field (through transect walks and aided by a mobile GIS) to delineate village boundaries and plot the location of development activities. The aim of the participatory mapping exercise is to reflect the people's local development needs and plans. This visualization tool is expected to serve the communication process between the local people and outsiders. In doing a participatory mapping exercise, local people gain more than a product – the map, but the local people may also find the method a good learning experience to know about their own resources (including shapes, sizes, locations and their comparative status to other resources) which are reflected in satellite images. In this case, participants see for themselves the status of land use and might reveal disparity of local spatial knowledge among community members, making the participatory mapping exercise a learning process.

METHODOLOGY

Initial Visits and Obtaining Community Consent

In March 2007, Prof. Wilfredo Alangui, the project leader, sent letters to local officials and community leaders in Tulgao and to another nearby community to explain the research project and to get their consent. During this time, the provincial office of the National Commission on Indigenous Peoples was conducting FPIC in relation to the proposed explorations. While initial feedback on the letters were positive, the team decided to delay the start of the research due to the sensitive situation brought about by conflicting community positions on the proposed explorations and geothermal project.

On 6 December 2007, Ms. Alicia Follosco went to Tinglayan to formally get research project endorsement from the municipality through its mayor, Hon. Johnny Maymaya. On 27-28 December, training on the use of GPS (Global Positioning System) for research was conducted for the research team and five (5) locals from Tinglayan. This was part of the capacity-building for both the team and the community. After the workshop, the research team and the Tinglayan participants finalized the research site, drew up the timetable and discussed preparations for the fieldwork.

On 17 January 2008, Mayor Maymaya visited UP Baguio and met with some members of the team led by Prof. Wilfredo Alangui. In this meeting, the mayor briefed the research team about the sensitivity of the situation in the communities brought about by the proposed geothermal project. Prof. Alangui assured the mayor that the team will not get involved on the issues surrounding the project.

Community Consultations

The team went to Tinglayan on 19 January 2008 and visited three barangays (Tulgao East and Tulgao West, and another village). The objective of the visit was to meet with the community people and obtain their consent for the project.

In Tulgao, the visit coincided with the *sapata,* a community event attended by household members from both East and West, and facilitated by the two barangay captains Mr. JosephOlao (Tulgao West) and Mr. Miguel Guyang (Tulgao East). The *sapata* was called that day to resolve the problem of theft of power cables used to operate the microhydro power plant that serviced the communities of Tulgao and Dananao. Almost every household was represented in the ritual, which required household representatives to swear their innocence before an antique jar wrapped with burial cloth. Everyone who swore on the jar was expected to tell the truth. Doing otherwise would invite tragedy to the person or to any member of the family. It was a chance for the team to observe an indigenous method of conflict resolution.

After the *sapata*, and after the research team was introduced by Mr. Joseph Olao, barangay captain of Tulgao West, Prof. Alangui was invited to explain the research project. Questions were raised and answered, mostly by the older men who were around. The two barangay captains later assured the team that we have obtained the consent of the two communities.

As soon as community consent was given by the community of Tulgao for the conduct of mapping and ecological and hydrologic inventory in the domain, the barangay leaders mobilized local councilmen and a few other individuals to provide support in the research.

They were also instrumental in the selection of field sites. Once clear about what the research required for the ecological and hydrologic survey, the local leadership in consultation with knowledgeable hunters and forest users helped find the appropriate actual field sites. Several areas were described and suggested until the appropriate sites were chosen based on the requirements and resources of the team.

The community contingent at the time of field work was composed of twelve (12) men and two (2) young girls. They assisted in hauling field supplies to the site, provided information and supported the research team in data collection as requested and again hauled down field materials and gathered specimens for analysis *ex situ*.

The following are descriptions of the methods used in each of the research component.

Geophysical Features

The general setting and surface features of the study area were determined by careful examination of the available maps obtained from NAMRIA, Bureau of Soils and Water Management and the Mines and Geosciences Bureau.

Rocks were collected with a sample pick at certain outcrops and examined under the hand lens. Water quality was examined with the YSI Model 85 handheld oxygen, conductivity, salinity, and temperature system. Water quality measurements were taken from four (4) field sites.

Fauna

Site

The collection area is located in Sitio Muscot at coordinates 17º28’41”E and 121º06’09”N, and covered approximately 1.19 hectares. It has at an altitude range of 1700 masl to 1900 masl. The area used to be a settlement in the late 1970s for several households who cleared some parts of the mossy forest for agriculture. According to a respondent, they abandoned the area because it was not fertile. Since then, the land was covered by tall grasses, dominated by *Miscanthus sp.* The surrounding thick mossy forest remains intact. The grass area is well noted for the many tracks of rodents, specifically diggings that are approximately 13 centimeters apart. The relatively thick organic layer of the area, which allowed easy digging in search for food, may explain such behavior.

Method

The standard procedure on trapping was used to assess the area. Small mammals were caught using Victor rat-traps, about 95 %, and National Live traps. The team used the earthworm and peanut butter-coated coconuts bait combinations for about 95 % of the baits. Earthworm baits were used for the rest.

Most of the traps were placed on the ground while the rest were placed on top of rocks, fallen logs and trees. They were laid at 2-5 meters distance. The traps were checked regularly at 7 in the morning, re-baited around 3 pm, and placed at sites different from their earlier position.

The trapping was done for seven (7) successive nights and a total of 774 trap-nights were set for the entire sampling period. Seven different sites were sampled in the entire stretch of the area. These consisted of five (5) sites covered by *Miscanthus sp.* and two (2) sites in the edges of the mossy forest.

The animals collected from each trap night were immediately processed. Body measurements (total body length, tail length, hind foot and ear length) were recorded. All collections were preserved in 10% formalin solutions and were subjected for confirmation of identifications. Bats and birds were sampled using mist nets. The method did not follow the standard and minimum number of trap nights to make a complete assessment. The nets were just left in the sites and were checked early in the morning and late in the afternoon. They were strategically positioned in edges of the forest and the grassland near water sources and trails. Some of the nets were moved into different sites during the 4th day. The collected specimens were measured and documented. To validate the initial identification of the specimens, the team consulted Mr. Danny Balete of the Chicago Field Museum.

Flora

A 10m x 50m plot was established in sitio Balugon, at coordinates 17º28’69”E and 121º06’53”N, which is within the territory of Tulgao West. The plot was investigated of its existing flora. All plants including fern and fern ally, gymnosperm and angiosperm representatives were collected as voucher specimens for identification. The voucher specimens were pressed on-site and transported to UP Baguio for drying and poisoning with sodium pentachlorophenate. It was then mounted on herbarium sheets. These specimens were then sent to Mr. Leonardo Co of the Conservation International for identification. On July 2008, the team went back for validation of preliminary results. The common names of the collected specimens were then provided by two hunter-elders.

Microbiology

Sampling Procedure

The acquisition of soil samples were done using a soil corer, a tool designed to get soil samples from fields. Six locations were selected by the researchers. The soil samples fromthese chosen locations were pooled into a plastic bag and kept for serial dilution and further processing in the laboratory.

Isolation and Purification of Microorganisms

Ten grams of soil in each of the samples was measured and transferred to a bottle with 90 ml sterile water. The serial dilution and spread plating techniques were done according to the method described by Westreich (1997). Petri plates were inoculated and incubated at 37_{o} C for 2 days. After which the number of viable microorganisms were estimated by counting the colony forming units (CFUs) per gram of soil sample collected.

Characterization of Microorganisms

The morphological characteristics of microorganisms were observed in each of the plates. After counting the viable number of microorganisms and describing their characteristics, morphologically different microorganisms each from the NA, (Nutrient Agar) and PDA (Potato Dextrose Agar) were selected and purified in freshly prepared media plates. These plates were then incubated for two to three days at 37_{o} C. After a day of incubation, the microorganisms cultured from Nutrient Agar plates were characterized further using biochemical tests.

Bacteria can be characterized and classified mostly by their enzymes or chemical reactions. As they are grown on different types of media, they produce certain types of metabolites that are detected by their interactions with test reagents, which may result in color change. The following biochemical tests were applied: Catalase test, Oxidase test, Casein hydrolysis, Hydrogen Sulfide Production, Gelatin hydrolysis, and Indole test.

Morphological characteristics and biochemical tests reactions served as basis for speculating probable bacterial genera known to exhibit these characteristics. Microorganisms cultured in PDA were characterized by examining a sample of their cells under a microscope, describing and noting their morphology using a key in identifying the genera of yeast and fungi.

Mapping

Data in various forms were collected to produce maps on Tulgao. The domain of Tulgao is made up of the two socio-political units, namely Tulgao East and Tulgao West. Informants claimed that in 1979, the two government units were created following an unresolved conflict between two barangay chairman aspirants. The solution to the conflict was to divide the barangay into two and give each individual one political unit to manage. In this study, however, the site is treated as one distinct domain (or *bogis* as is the local term) that is occupied by one ethno-lingustic group, called the *i-Turkao*.

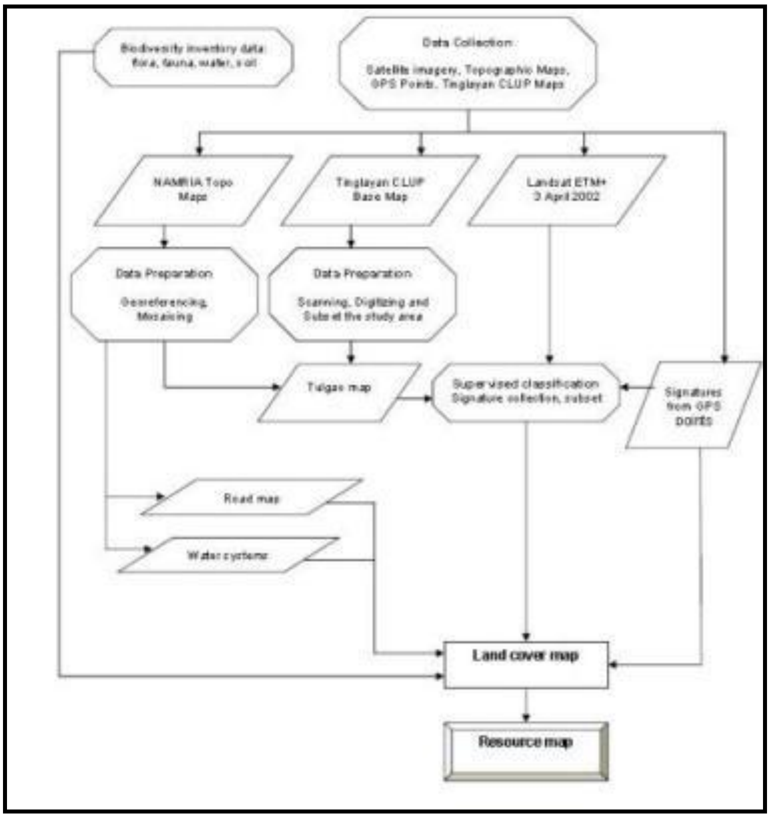
Topographic maps with a 1:50,000 scale were acquired from the National Mapping and Resource Information Authority (NAMRIA). The Lubuagan and Sallapadan sheets in particular were scanned, geo-referenced and joined (made into a mosaic) to locate Tulgao.
Similarly, the base map of Tinglayan in the approved Comprehensive Land Use Plan (2004) was scanned, geo-referenced and digitized. A municipal map was created, from which the political boundaries of the two Tulgao barangays were taken. In addition, visible features in the topographic maps, such as creeks and rivers within the area were also digitized.

A Landsat ETM+ scene with a 30-meter spatial resolution (dated April 3, 2002) was acquired. Using the political boundary of the Tulgao domain extracted from the CLUP, a subset of the area was taken from this satellite image, and henceforth was used to perform image classification to generate a land cover map.

Image classification with Image Processing Software is a "process of classifying multispectral images into patterns of varying gray or assigned colors that represent clusters of statistically different sets of multiband data, some of which can be correlated with separable classes or features. It is used to convert spectral raster data into a finite set of classifications that represent the surface types seen in the imagery. As such, it can be used to identify different vegetation types, anthropogenic structures, and other natural resources... and the classified raster image can be converted to vector features, for example, polygon, in order to compare with other data sets or to calculate spatial attributes, like area" (Tiburan: 2008).

Due to resource and time constraints, image classification was done as an alternative to generate the land cover/land use of Tulgao. The area per land cover/land use as computed from the classification was thus treated as indicative and not authoritative, especially since the satellite image is also not recent**.** The flowchart below describes the steps followed by the project in generating the resource map.

Figure 2: Steps in Creating the Resource Map



Training points were generated using GPS receivers. Positional data were collected in January, April and July 2008 and used to classify the image, arriving at an indicative land cover classification of the area. Ground truthing was limited and done in the settlement and accessible agricultural areas. In the course of data collection in April, positional data on the sampling sites were also generated and plotted in a map (see two maps below).

Figure 3: Map showing the sampling areas plotted in the April 3, 2002 Landsat ETM+ Satellite Image

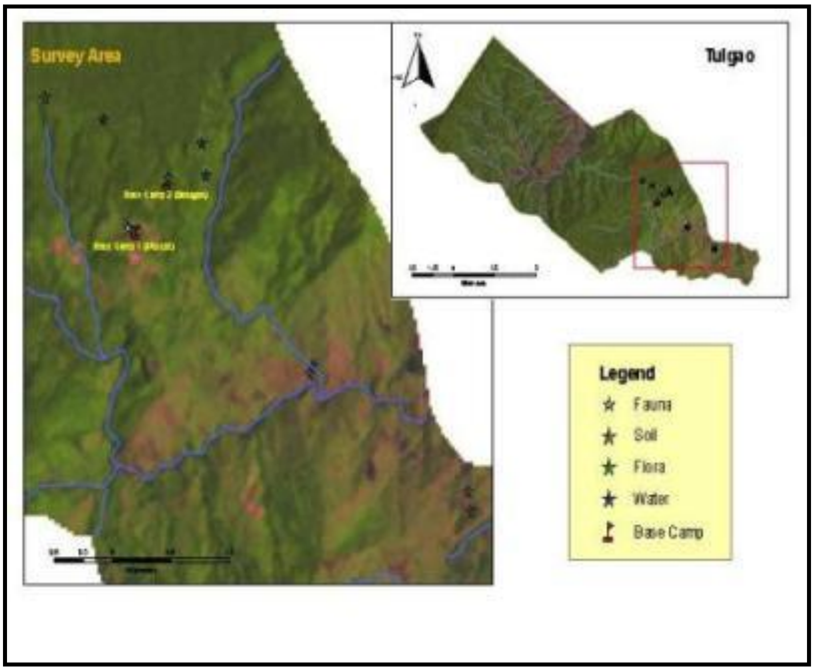
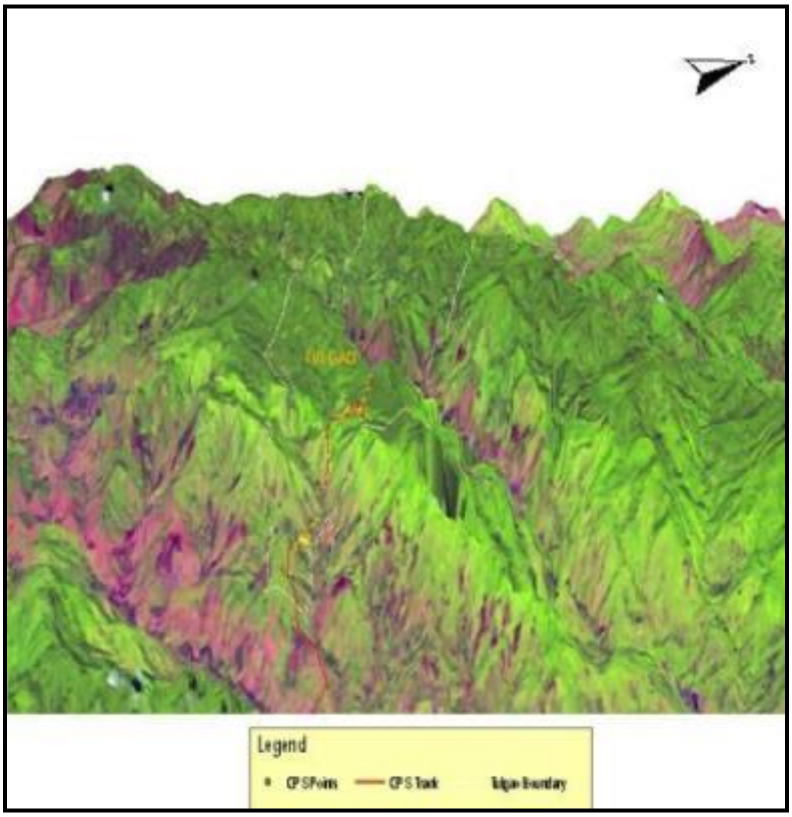


Figure 4: Survey sites in 3D View (Background: April 3, 2002 Landsat ETM+ Satellite Image, Exaggeration: 2)



LIMITATIONS OF THE STUDY

Limited resources and time constraints, as well as the difficult terrain prevented the team from reaching Mount Mosimus which was the original target site. While the research focused on areas that may be classified as ‘disturbed,’ the results obtained may serve as indicators of what lies in the thickly forested and relatively untouched forests of Mount Mosimus.

Some of the limitations per component are enumerated below.

• The results obtained for the geology component are at a reconnaissance level only. The following posed as limitations to fully accomplishing the objectives of the study: limited geological work (public domain) by earlier workers in the area, accessibility to the field site, and unavailability of complete digital data and appropriate software for storing digital information.

• The Microbiology group attempted to isolate and purify fungal isolates, but had difficulty in growing them in the laboratory media. Very few or scanty growth was observed making it difficult to characterize the fungi found at the different sampling sites. Hence, the focus of the study was limited to the bacterial isolates.

RESULTS AND DISCUSSION

Geophysical Features

Morphology and Drainage

The highest elevation in Tulgao is at 2525 masl in Mount Cauitan in the south. The second highest elevation is at 2468 masl in Mount Bangbanglang in the west. The lowest elevation is 800 masl, adjacent to a hot spring discharge point in Tinglayan River. Slopes vary from steep (30-50%) to very steep (>50%). Relief is generally rugged.

Tulgao belongs to the watershed demarcated by the Mount Mauban drainage divide. It is drained by Pasil and Tinglayan rivers in the northwest and the southeast, respectively. The Pasil and Tinglayan rivers flow to the northeast and east, respectively, to join the Chico River, which then drains through the Cagayan Valley and into the Babuyan Channel. Drainage pattern is predominantly dendritic (like tree branches) and radial around inferred volcanic peaks, such as Mount Mosimus and Mount Binulauan.

Land Use

Surrounding the Pasil headwaters east of Mount Bangbanglang are gullies of open grasslands. Adjacent to Mount Mauban, down to the Balay settlement, the forest is the dominant land use. At Balay and going east towards Tulgao residences, grassland is observed in association with shrubs and various plantations such as rice, beans and bananas. The two sampling sites in Balugon and Muskot are within the forest area.

Soil and Rock

In the west and central region of the barangay, soils in the area are mostly unclassified mountain soils. In the vicinity of Balay and Tulgao, clay loam predominates.

Near its northwest end in the vicinity of the headwaters of Pasil, Tulgao is underlain by andesite/diorite intrusives. Towards the east, it is underlain by metavolcanics and metasediments, interspersed with wackes and conglomerates, and intermediate flows and pyroclastics. Pillow lavas in the field are shown in Figure 5. A small outcropping diorite intrusive is being extracted to make stone stoves for domestic use (Figure 6). Most rocks are used primarily as retaining walls for trails, rice fields and residences.

In the two major sampling sites in Muscot and Balugon, outcrops of tan- to gray-colored tuffs and tuffaceous sediments were encountered. Durkee and Pederson (1961) and Peña (2008) report a dacitic composition for the sediments. Well-formed crystals of quartz and feldspar were observed. The rocks were further recognized by Durkee and Pederson (1961) as valley filling deposits in the Pasil and Chico River valleys and are part of the Awidon Mesa Formation of Pleistocene age. The volcanic rocks, hot springs, gas emitting vents (Figure 7) and radial drainage confirm the volcanic nature of the area. The topography north of the sample sites suggests deposits that could possibly have been erupted towards the southwest from Mount Mosimus and Mount Binulauan. The northeast-trending range containing peaks from Mount Cauitan to Mount Binulauan appear to delimit one side of the deposits.

Figure 5: Pillow lavas behind our field aides

Figure 6: Indigenous stove carved from diorite. Top view (left) and bottom view (right)

Figure 7: Gas emitting vent (encircled) looking north towards Mount Binulauan

Water Quality

At creeks higher than the field collection sites, dissolved oxygen measurements were taken. Saclit and Pinit creeks, with elevations of 1853 masl and 1775 masl, measured DO levels of 9.3 and 13.8 milligrams per liter respectively, and an average water temperature of 13.5 degrees Celsius. Based on the DO values, these waters may be classified as Class AA, a classification that meets the intended quality of water from watersheds that are uninhabited and otherwise protected; disinfection following approved methods is necessary in order to meet the National Standards for Drinking Water of the Philippines (DENR DAO 34).
At the confluence of Bonog and Tinglayan creeks downstream of Balay and Tulgao East, DO measured to be 6.3 milligrams per liter. The lower DO could be a result of stronger anthropogenic impact in this area. It has been recognized that pollutants, such as agricultural runoff or sewage could build up organic matter that can be broken down by microbial decomposers as they conserve dissolved oxygen.

Fauna

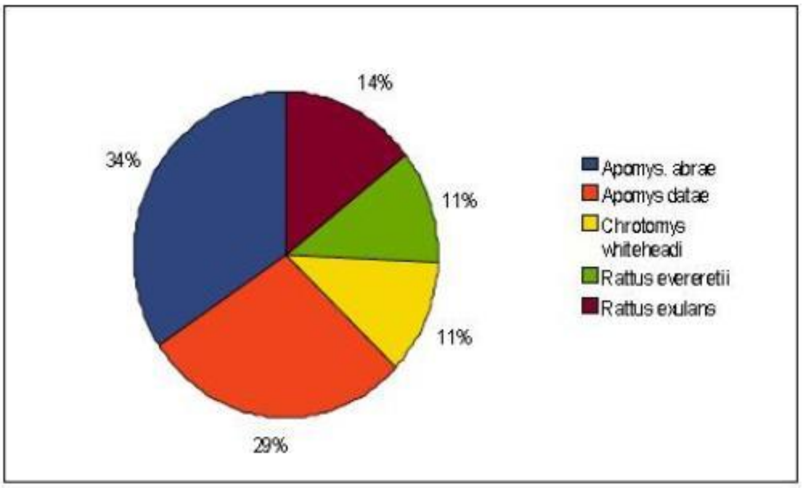
Six species of mammals were collected from the trappings conducted from April 17-23, 2008. Five species were murids (Family Muridae), namely *Apomys abrae*. *Apomys datae*, *Chrotomys whiteheadii*, *Rattus everetii*, an*d Rattus exulans*, and one species of bat (Family Pteropodidae) identified as *Otopteropus cartilagonodus*.

Four species of birds were collected: *Spilornis cheela* or crested serpent eagle, *Pachycephala Lanius cristatus.* During the initial visit in January 2008, the team bought three hunted birds from an elderly woman resident of Tulgao West. The birds turned out to be *P. marchei*.

From 774 traps set, the team collected ten (10) individuals of *Apomys abrae*, twelve (12) *Apomys datae*, four (4) *Chrotomys* c*whiteheadii*, four (4) *Rattus everetii,* and five (5) *Rattus exulans*. Most of the individuals that were collected were trapped in parts where *Miscanthus* grows. Unfortunately, some of the *Apomys* cannot be accurately identified because key morphological features cannot be identified. All in all, 22 Genus of *Apomys* were collected.

The densities of the five rodent species were compared and are illustrated in the diagram below (Figure 8). Note that among the entire collection, *Apomys abrae* recorded the highest density, comprising 34%; but if grouped into a single genus, 63%.

Figure 8: Density of individuals per species



Using data on frequency, both *Apomys abrae* and *Apomys datae* showed the highest frequencies, at 86 % (see Table 1 below). If clumped into the genus *Apomys*, the frequency will be 100%.

Table 1: Frequency Distribution of Collected Species of Rodents

Species	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Rel Frequency
Apomys. abrae	x	x	x	x	x	x	-	85.71
Apomys datae	x	x	-	x	x	x	x	85.71
Chrotomys whiteheadi	x	-	x	-	-	-	x	42.86
Rattus everetii	-	-	-	x	x	x	x	57.14
Rattus exulans	-	-	-	x	-	x	x	42.86

Among Philippine forest rodents, the genus *Apomys* belongs to Family Murinae and includes the most new species (Goodman & Ingle, 1993). *Apomys*, a branch of the earthworm eaters, also ingest seeds and some climb trees. More than 15 species have evolved in this branch, often reaching new volcanic islands not long after they emerge from the sea (Heaney, 2005). The frequencies and abundance record of this group may suggest that they are the main individuals that caused most of the tracks observed in the area.

Apomys abrae (Sanborn, 1952) is recorded with the common name Luzon Cordillera Forest Mouse. It is **Endemic** to the Central Cordillera of Northern Luzon. Museum records of it are from Abra, Benguet, Ilocos Norte, and Mountain Provinces. It is moderately common in primary forest and second growth forests, at elevations of 1000 masl to 2000 masl, and occasionally, up to 2500 masl. Its reported status is **Probably Stable** (see Appendix A, Figure A.1).

Apomys datae (Meyer, 1899), also known as Luzon Montane Forest Mouse, is **Endemic** to Northern Luzon. It has been recorded in primary montane and mossy forest from 750 masl to 1650 masl elevation in the Sierra Madre and from 1660 masl to 2500 masl in montane and mossy forest in the Central Cordillera. Museum records are from Benguet, Cagayan, Ilocos Norte, Isabela and Mountain Province. Its status is **Moderately Common and Widespread**.

The data however, also suggest that *Chrotomy whiteheadii* and the species of *Rattus* have relatively high reproductive status.

Chrotomys whiteheadii (Thomas, 1895) is recorded with the common name Luzon Montane Striped Shrew Rat. Its reported distribution is in mossy forest from 2300 masl to 2500 masl in the Central Cordillera, Luzon. The museum records are from Benguet and Mountain Provinces only. But a report from Heaney et. al (2000) have already confirmed the presence of this species in Kalinga Province. The recorded Status is **Uncertain** but Heaney, *et al* (1997) stated that it may be moderately common and widespread in the Central Cordillera (Appendix A, Figure A.2). The capture of this species by our team at lower elevations, 1700 masl to 1900 masl, suggests that their habitat is relatively wider than it is first perceived.

Rattus everetii (Gunther, 1879) is also called Common Philippine Forest Rat (Appendix A, Figure A.3). It is **Endemic** but widespread in the Philippines (except in the Palawan and Sulu faunal regions and the Batanes/Babuyan groups). In the Cordillera, museum records are from Abra, Benguet and Mountain Provinces. Its habitat covers primary and disturbed lowland, montane and mossy forest, from sea level to 2200 masl in Luzon Island. The Status is **Common** in primary forest, **Uncommon** in secondary forest, and **Usually Absen**t in agricultural areas.

Rattus exulans (Peale, 1848) was first described in U.S. Expl. Surv., 8:47. Its common names are Polynesian rat and Small spiny rice-field rat. According to Alcala & Alviola (1970), its distribution is from Bangladesh to Easter Island and throughout the Philippines. Its habitat covers agricultural areas throughout the country at all elevations (Barbehenn et al., 1973; Rabor, 1986), is often present in disturbed forest (Danielsen et al., 1994), and is usually rare in primary forest, but may be **Common** in primary forest on islands such as Negros with few native rodents (Heaney et al., 1989). The status of *R. exulans is* **Non-native and Abundant** (Figure 9 below).

Figure 9: Rattus exulans

The collected murids and their distribution and status are summarized in Table 2 below.

Table 2: The collected murids, their distribution, and status (Heaney *et al.*, 1997)

Species	**Distribution**	**Status**
Apomys cf. abrae	Endemic to the Central Cordillera of Northern Luzon	Probably Stable
Apomys cf. datae	Endemic to Northern Luzon	Moderately Common and Widespread
Chrotomys cf. whiteheadi	Endemic to Central Cordillera, Luzon	Uncertain
Rattus everetii	Endemic but widespread in the Philippines	Common in primary forest, Uncommon in secondary forest, and Usually Absent in agricultural areas
Rattus exulans	Non-native	Abundant

From seven (7) days of mist-netting, five individuals of species *Otopteropus cartilagonodus* (Kock, 1969) were collected. The species belongs to Family Pteropodidae, consisting of fruit bats. One was observed early morning while it was flying around a clump of banana plants. Its common name is Luzon pygmy fruit bat. It is **Endemic** to the Philippines where it is widespread in Luzon Island and is known only from primary and well developed secondary forest in lowland, montane and mossy forest from 200 masl to 1900 masl. The abundance is low to moderate, usually common at middle elevations. Status is reported as **Apparently stable** because of its primary use of middle and upper elevation forest, **but poorly known**. The International Union for Conservation of Nature (IUCN) classified it as **Endangered** but Heaney *et al.* (1997) consider the listing to be premature.

Figure 10: Otopteropus cartilagonodus

During the field work, the local hunters who served as field guides were shown images of some mammals reported to be found in Luzon. They pointed to the *Phloeomys pallidus* (Nehring, 1890)**.** They informed us that this rodent is found in their forest. *P. Pallidus* belongs to Family Muridae. Its common name is *Bu-ot* or Northern Luzon giant cloud rat and is reportedly widespread in Kalinga-Apayao, Laguna and Nueva Viscaya provinces (Oliver et al., 1993a), and recently verified from Bataan/Zambales region (Ong, unpubl. data). The species' habitat ranges from sea level to high mountains (at least 2000 masl), in primary and secondary forest (Rabor, 1955; Thomas, 1898) and heavily disturbed scrub (Oliver et al., 1993a). The reported status is **Widespread**, apparently common in forests and hunted (Pasicolan, 1993; Oliver et al., 1993a). The same hunters informed us that they use air gun to catch birds. During the first visit to the place in January 2008, some locals offered to sell us 3 dead flame-breasted pigeons, *Ptinolopus marchei* (see Appendix A, Figure A.10).

The guides also confirmed that they are able to trap *Sus philippensis*, the Philippine warty pig or *whawhoy* in the local language and the *Cervus mariannus*, commonly named the Philippine brown deer or *ugsa*. In fact, the research team saw two live deer being reared in Dananao.

Figure 11: Cervus marianus

Cervus mariannus is one of the three species of deer that are reported in the Philippines, all of which are endemic to the country.

Flora

There were a total of fifty seven (57) vascular plant species that were collected, representing thirty six (36) families. Angiosperm representatives totaled fifty (50) species. There was only one (1) gymnosperm representative and fourteen (14) vascular cryptogam species. The table below (Table 3) summarizes the collection from the site.

Table 3: Flora Collection from Sitio Balugon

Collection number	Family	Genus/ Species	Common Name
46001	**Guttaceae**	*Garcinia* sp.	basag
46002	**Orchidaceae**	*Dendochrilum* sp.	suyayon
46003	**Lauraceae**	*Actinodaphne* sp.	longboy
46004	**Labiatae**	*Gomphostema javanicu* (Blume) Benth.	olac
46005	**Orchidaceae**	*Crepidium(?)* sp.	solngang
46006	**Myrtaceae**	*Syzygium* sp.	gasatan ongor
46007	**Piperaceae**	*Piper* sp.	basag
46008	**Dryopteridaceae**	*Acrophorus nodosus* sp.	aramam
46009	**Euphorbiaceae**	*Macaranga* sp.	anablon
46010	**Hymenophyllaceae**	*Cephalomanes apiifolia* (C. Presl) K.(Iwats)	manapo
46011	**Rutaceae**	*Melicope* sp.	alindadanum
46012	**Podocarpaceae**	*Dacrycarpus* sp.	bukon/chungon
46013	**Rubiaceae**	*Lasianthus* sp.	apiiton
46014	**Selaginellaceae**	*Selaginella involvens*	shaer

46015	**Fagaceae**	*Lithocarpus* sp.	palong
46016	**Polypodiaceae**	*Selliguea* sp.	uliay
46017	**Orchidaceae**	*Dendrochilum* sp.	palutput
46018	**Sabiaceae**	*Meliosma simplicifolia* (Roxb.) Walp.	palayon uyupan
46019	**Proteaceae**	*Helicia robusta* var. *robusta* (Roxb.) R. Br. Ex Wall.	apitan
46020	**Dryopteridaceae**	*Atachnoides amabilis*	aramam
46021	**Piperaceae**	*Piper* sp.	
46022	**Symplocaceae**	*Symplocos* sp.	shurkisik
46023	**Begoniaceae**	*Begonia* sp.	jejepiel
46024	**Gesneriaceae**	*Aeschynanthus* sp.	umug
46025	**Polypodiaceae**	*Selliguea albidosquamata* (Blume) Parris	batbatan
46026	**Rubiaceae**	*Lasianthus* sp.	
46027	**Polypodiaceae**	*Goniophlebum* sp.	bagaybay
46028	**Piperaceae**	*Piper* sp.	lawod
46029	**Urticaceae**	*Elatostema bontocense* Merr.	
46030	**Aspleniaceae**	*Asplenium* sp.	kalutkot
46031	**Lindsaeaceae**	*Lindsaea* sp.	
46032	**Rosaceae**	*Rubus fraxinifolius* sp.	bayas-an
46033	**Vitaceae**	*Cayratia* sp.	danum
46034	**Elaeocaceae**	*Elaeocarpus* sp.	uling
46036	**Araceae**	*Arisoema* sp.	sagot
46037	**Aceraceae**	*Acer laurinium* Hassk.	langlangpaw
46038	**Cannabaceae**	*Cannabis sativa*	marijuana
46039	**Melastomataceae**	*Melastoma* sp.	Basicalang
46040	**Labiatae**	*Gomphostema javanicum*	mangadawuyon
46041	**Urticaceae**	*Elatostema* sp.	nangor
46042	**Aspleniaceae**	*Asplenium* sp.	aramam
46043	**Grossulariaceae**	*Polyosma* sp.	manga ti bantay
46044	**Lycopodiaceae**	*Huperzia* sp.	
46045	**Rutaceae**	*Melicope* sp.	gasatan
46046	**Chloranthaceae**	*Sarcandra glabra* ssp. *Brachystachys*	itsa
46047	**Labiatae**	*Plectranthus merrillii* (Merr.)	manaba
46048	**Fagaceae**	*Lithocarpus* sp.	marwa
46049	**Zingiberaceae**		banoy
46050	**Pteridaceae**	*Vittaria* sp.	susurkod
46051	**Polypodiaceae**	*Microsorum* sp.	bangbang-aw
46052	**Araliaceae**	*(?)Schefflera* sp.	marganganga
46053	**Urticaceae**		wild olac
46054	**Zingiberaceae**		
46055	**Begoniaceae**	*Begonia* sp.	chupchupil
46056	**Myrsinaceae** *Discocalyx* sp. alinchaharom		
46057	**Dryopteridaceae**	*Elaphoglossum* sp	
46058	**Melastomataceae**	*Medinilla* sp.	hurhwahwang
46060	**Rubiaceae**	*Canthium* sp.	
46061	**Euphorbiaceae**	*Macaranga* sp.	nijapon
46062	**Grossulariaceae**	*Polyosma* sp.	
46063	**Myrtaceae**	*Syzygium* sp.	basag
46064	**Myrtaceae**	*Syzygium* sp.	basag
46065	**Melastomataceae**	*Medinilla* sp.	kahwahwang
46066	**Rosaceae**	*Prunus* sp.	

Plant species from the collection site shows typical tropical montane rainforest vegetation. Representative genera are *Macaranga, Garcinia, and Syzygium*. Higher elevation and temperate genera are also found such as *Polyosma, Lithocarpus, Dacrycarpus and Rubus*. The presence of diverse understory vegetation which includes *Medinilla, Asplenium, Dendrochilum,* *Crepidium, Cephalomanes, Arisaema, Selaginella, Elastotema, Acrophorus, Atachnioides* and *Elaphaglossum* is an evidence of a relatively open canopy. *Arisaema* and *Cephalomanes* and the observed profuse growth of mosses are proofs that the microclimate in this type of forest is relatively humid.

Mt. Sto. Tomas (2256 masl), south of Baguio City shares a similar vegetation type with Tulgao. Sixteen families are common to both sites. These are Gesneriaceae, Araliaceae, Myrsinaceae, Aspleniaceae, Begoniaceae, Polypodiaceae, Euphorbiaceae, Orchidaceae, Elaeocarpaceae, Lamiaceae, Sabiaceae, Piperaceae, Rubiaceae, Rosaceae, Chloranthaceae and Zingiberaceae. Common genera between these two sites are *Aeschynanthus, Begonia, Elaeocarpus, Gomphostema, Meliosma, Piper, Polyosma, Rubus* and *Sarcandra*. Mt. Data, in Bauko, Mt. Province, is another montane forest of similar vegetation character with that of Tulgao. These two sites share 20 families in common namely, Aceraceae, Araliaceae, Elaeocarpaceae, Fagaceae, Grossulariaceae, Lauraceae, Melastomataceae, Myrsinaceae, Myrtaceae, Podocarpaceae, Araceae, Aspleniaceae, Chloranthaceae, Hymenophyllaceae, Orchidaceae, Piperaceae, Polypodiaceae, Selaginellaceae, Symplocaceae and Urticaceae. It has been observed that there may be more families common between the two sites but because of the limited area sampled, not all of the plant families were scored.

Some of the collected plants have existing or possible economic importance. Many are beautiful ornamental plants such as *Medinilla, Huperzia, Selaginella* and *Cephalomanes*. Several are cited having medicinal properties. One of these plants is *Huperzia*, the source of currently investigated type of secondary metabolites referred to as huperzines. Huperzines are the focus of research regarding Alzheimer's disease. Others such as *Selaginella* are also associated with the treatment of gastric cancer and tumor inhibition. *Cephalomanes* is an example of a plant traditionally used as herbal medicine. In Malaysia, it is mixed with garlic and onions then smoked like tobacco to treat headache. It is also used to treat wounds caused by snake bites. *Sarcandra glabra* is another species that has economic importance. It is currently utilized as a beverage tea called *itsa*. Co (1989) mentions several uses for this plant including treatments for pneumonia, acute gastroenteritis, post-operative infections, scalds and burns, rheumatic arthritis, traumatic injuries and bone fractures.

Microbiology

Six soil samples were collected from six sampling sites and the colony forming units (cfu's per gram of soil collected) were estimated using the dilution plate count method as shown below in Table 4.

Table 4: Comparison of Colony Forming Units per gram of soil using the dilution plate count method among the different sampling sites

Site	Dilution factor
	10^4
Site 1 (Muskot)	2.255 x 10^6
Site 2 (river slope)	6.45 x 10^5
Site 3 (river basin)	2.05 x 10^5
Site 4 (agricultural land)	1.95 x 10^6
Site 5 (settlement)	2.12 x 10^6
Site 6 (Tanap)	2.69 x 10^6

The agricultural land has the most number of cfu's per ml of diluted soil sample followed by the settlement area (sites 4 and 5) while the river basin (site 3) had the least number of cfu's per gram of soil sample. As discussed by Wollum (1994), agricultural land may be affected by the rhizosphere. Rhizosphere is the portion of the soil that is directly under the immediate influence of the plant root. Generally, microorganisms are found in greater numbers and diversity in the rhizosphere soil compared with non-rhizosphere soil. In the settlement area there were probably rhizophere soil too since the locals tend to plant in the vicinity of their households for their personal consumption.

The least number of cfu's/gram of soil were found in sites 2 and 3 which were from the river slope and river basin respectively. It was also observed that in the Site 2 sample, spreading pattern of growth was evident wherein counting was quite difficult so only few recognizable colonies were considered for counting. The possible explanation for this observation is that bacterial colonies found in rivers that included sites 2 and 3 are usually colonized into biofilms. Biofilms are microbial cells encased in an adhesive, usually a polysaccharide material and attached to a surface (Alexander, 1999). According to Sabater *et al.* (2002), biofilms are an ensemble of autotrophs and heterotrophs, which are highly efficient in removing inorganic and organic compounds, as well as other chemicals, from river water.

They are, therefore, key elements in the self-purification processes which occur in rivers. Biofilm function is related to several environmental factors that govern river ecosystems: physical (light, temperature, water current), chemical (nutrient availability, toxicant effects), but also biological. Among the biological factors, community composition (algae, bacteria and fungi), biofilm structure (layer arrangement and biomass accumulation), and the presence of grazers determine variations in the efficiency of the self-depuration function of biofilms in rivers. This is therefore an interesting area to work on in future studies, since river microbial communities play an important role in global nutrient cycles and aggregated bacteria in biofilms especially present in river basins maybe important contributors.

Biochemical Tests

After successive purification procedures, twenty four morphologically different colonies were selected and subjected to biochemical studies and gram staining procedures.

The biochemical tests used in the study were the following TSI (triple sugar iron) or H_2S production, catalase test, casein hydrolysis test, oxidase test, indole test, and the gelatine hydrolysis test. These biochemical tests undertaken were based on the chemicals available at the Microbiology Laboratory of UP Baguio. Results are shown in Table 5.

Triple Sugar Iron Test or Hydrogen Sulfide Production Test

This test is employed to determine the ability of an organism to attack a specific carbohydrate incorporated into a basal growth medium with or without the production of gas, along with the determination of possible hydrogen sulfide production. The appearance of black ferrous sulfide indicates the production of hydrogen sulfide gas. It is also a characteristic preparation used to differentiate gram negative enteric organisms by their ability to ferment dextrose (or glucose), lactose or sucrose to reduce sulfites to sulfides. All of the isolates were negative for H_2S production and gas production since there was no blackening observed along the line of inoculation. Only color changes were observed: red to yellow change in color is an indication that it is positive for dextrose fermentation, while completely yellow color observation is an indication that it is positive for lactose and or sucrose fermentation. Red color formation, meaning no change in color was observed in the medium used since TSI was red in color was an indication of no fermentation that occurred. This was evident in isolates no 4, 13 and 18.

Table 5: Results of Biochemical Tests and Gram Staining Procedures for the 24 selected isolates from the six sampling sites

Isolate No.	H_2S production	Casein hydrolysis	Catalase test	Oxidase test	Indole test	Gelatin hydrolysis	Gram stain
1	red/yellow	-	+	+	-	+	-bacilli
2	red/yellow	-	+	+	-	+	+ cocci
3	red/yellow	-	+	+	-	+	- bacilli
4	red	-	+	+	-	+	- cocci
5	red/yellow	-	+	+	-	+	- bacilli
6	yellow	-	+	+	-	+	- cocci
7	yellow	-	+	+	-	+	- cocci
8	yellow	-	+	+	-	+	+ cocci
9	red/yellow	-	+	+	-	+	- bacilli
10	red/yellow	-	+	+	-	+	- cocci
11	yellow	-	+	+	-	+	- cocci
12	yellow	-	+	+	-	+	+ bacilli
13	red	-	+	+	-	+	- cocci
14	yellow	-	+	+	-	+	- cocci
15	orange	-	+	+	-	+	- cocci
16	orange	-	+	+	-	+	- cocci
17	red/yellow	-	+	+	-	+	- cocci
18	red	-	+	+	-	+	- cocci
19	red/yellow	-	+	+	-	+	- bacilli
20	yellow	+	+	+	-	+	+ bacilli
21	red/yellow	+	+	+	-	+	+ bacilli
22	red/yellow	+	+	+	-	+	+ bacilli
23	red/yellow	-	+	+	-	+	+ cocci
24	yellow	+	+	+	-	+	+ bacilli

Catalase Test

The catalase test was undertaken to detect for the presence of the enzyme catalase which is usually present in most bacteria. It catalyzes the breakdown of hydrogen peroxide with the release of free oxygen. The formation of bubble upon the addition of hydrogen peroxide indicates a positive result. All isolates in this study gave a positive result for the catalase test as indicated in the table above.

Casein Hydrolysis

This test was used to determine the action of the organism on milk. Milk naturally contains substances like lactose, glucose, proteins, fats and vitamins. The appearance of clearing zones indicates a positive result for the production of the caseinase enzyme in the bacteria. Isolates no. 20, 21, 22 and 24 gave positive results, while all the rest of the isolates gave negative results.

Gelatin Hydrolysis

Gelatin is a protein that is solid at room temperature. If a bacterial isolate makes the enzyme gelatinase, the gelatin is hydrolyzed and becomes a liquid. Liquefaction of the gelatine indicates a positive result. In this study, all the isolates gave a positive result indicating that all of the isolates were able to break down the protein gelatin and liquefaction was observed.

Oxidase Test

This test is used to determine the presence of oxidase enzymes. The reagent which was impregnated into strips of filter paper contains tertramethyl-p-phenylenediamine which served as an alternate substrate for the cytochrome oxidase reaction. In the reduced state the reagent is colorless but when oxidized it becomes purple. The occurrence of a purplish color indicates a positive result. Among the twenty four isolates in this study only one (isolate No. 10) gave a negative result for the oxidase test.

Indole Test

This test is used to detect the ability of an organism to breakdown tryptophan to indole. The appearance of a purple red ring indicates a positive result. In our isolates, no indole production was observed, or all isolates gave a negative result for the indole test.

Gram Staining

Gram staining is a widely used method for characterizing and identifying bacteria based on the nature of their cell walls. Gram positive bacteria have thick peptidoglycan layer composed of glucose, muramic acid and polypeptides arranged in lattice-like formation that is responsible for the rigidity of the cell wall. Gram positive bacteria appear purple after gram staining because the primary stain and iodine form a compound that is relatively insoluble in the decolorizing agent. Their thick peptidoglycan layer also holds and encloses the crystal violet iodine compound firmly in the cell's cytoplasm repulsing the effect of the decolorizer as well as the countersain applied afterwards retaining their purple color.

Gram negative bacteria on the other hand, have thin peptidoglycan layer appearing red or pink after staining since the cell wall of gram negative bacteria will not bind on the positive dye and therefore it will absorb the counterstain, safranin. Gram staining results in this study revealed that among our 24 isolates, eight (8) were gram positive organisms and sixteen (16) were gram negative. Table 2 also shows the form of the various bacteria studied: bacilli are rod shaped microorganisms while cocci are spherical or circular in shape.

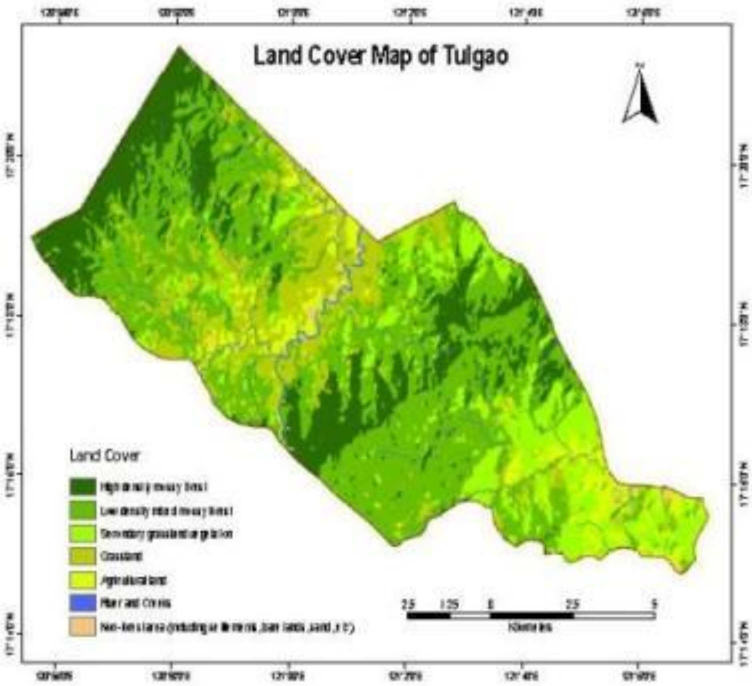
Possible Genus of the Bacterial Isolates

Based on biochemical tests and gram staining procedures and with the aid of Bergey's Manual of Determinative Bacteriology and Cowan and Steel's Manual for the Identification of Medical Bacteria, we have traced the possible Genus of our isolates. Gram negative bacilli (Isolates no 1, 3, 5, 9 and 19) could possibly be *Aeromonas, or Vibrio* species. The Gram negative cocci (Isolate no 4, 6, 7, 11, 13, 14, 15, 16, 17) could possibly be *Neisseria* sp. The Gram positive bacilli (Isolates No 12 ,20, 21 ,22 and 24) could possibly belong to *Corynebacterium* sp. The genus *Corynebacterium* consists of an extremely diverse group of bacteria including animal and plant pathogens as well as saprophytes. Some species are pathogenic like *Corynebacterium diphtheria.* The gram positive cocci (Isolates No. 2, 8 and 9) could possibly be *Micrococcus, Staphylococcus,* or *Enterococcus*.

Mapping

The output of an image classification exercise is a land cover map of Tulgao (see Figure 12 below). Results of the classification showed that of the classified area of 10,527.13 hectares, low density mixed forests made up close to 40%. High density mossy forest was made up of over 20%; grasslands constituted almost 16%, and secondary grassland vegetation close to 15%. A small portion at 5.83% was utilized for agriculture, mostly for rice (see following table). At the start of the cropping season for other subsistence or cash crops like white beans, black beans, mongo, and pigeon pea, many portions of the grasslands and areas with secondary grassland vegetation are cleared.

Figure 12: Land Cover Map of Tulgao



An older satellite image dated February 2, 1990 was likewise classified using the same training points to show changes in land cover over a 12-year period. The results showed that there was a significant reduction in the size of the high density mossy forest to as much as 1,700 hectares or 45% (Table 6), and a notable increase in area of low density mixed forest by 1,302 hectares or 11%. Secondary grasslands and agricultural lands have likewise expanded, while non-forests have become smaller, indicating possible conversion to secondary grassland vegetation areas (see Figure 13). A negligible percentage has been classified as water body, but ignored in this analysis, because the water system in general was not part of the classification, and especially since water bodies was not part of the classification.

Table 6: Comparison of the results of land cover/land classification (1990 and 2002)

Class Name	Class Area				Difference	
	1990		2002			
	Hectares	%	Hectares	%	Hectares	%
High density mossy forest	3,844.87	37	2,133.71	20	-1711.16	45
Low density mixed forest	2,870.09	27	4,172.39	40	1302.3	11
Secondary grassland vegetation	833.45	8	1,536.00	15	702.55	84
Grassland	1,759.09	17	1,679.46	16	-79.63	5
Agricultural lands	530.40	5	613.58	6	83.18	16
Non-forest	426.67	4	114.48	1	-312.19	73

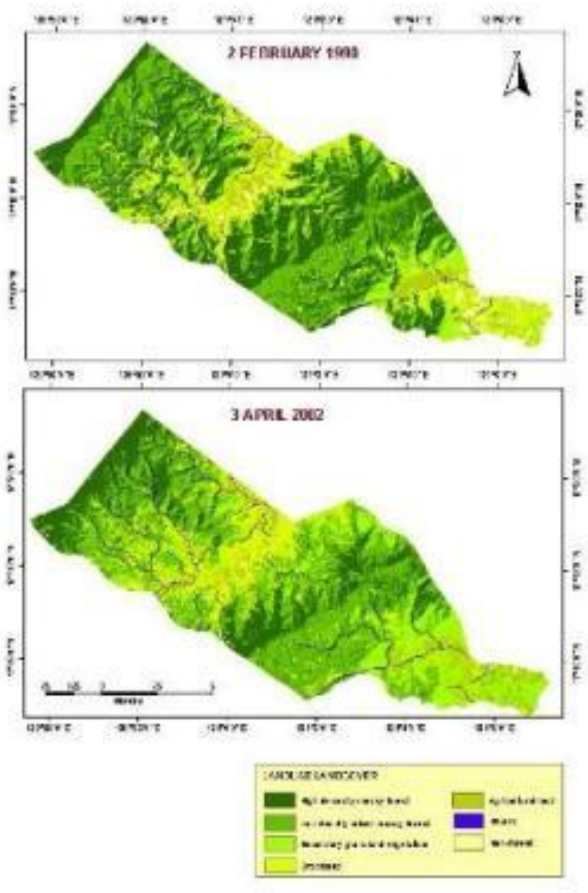
Rivers	*245.62*	*2*	*277.50*	*3*	*31.88*	*13*
	10,510. 19	100	10,527.13	100	-	-

Based on the classified images, some patch metrics were computed using Fragstats, a spatial pattern analysis program for quantifying landscape structure. The table below shows a comparison of number of patches and largest patch index in 1990 and 2002. Notable is the increase in the number of patches of the high density mossy forest, and a reduction of the other classes, especially low density mixed forests, secondary grasslands and grasslands, implying that there has been a disturbance in the high density forests causing more degraded land covers to predominate. In terms of largest patch index, there was a marked reduction from 5.47 to 2.68 for the high density mossy forest. All other classes have increased. These indicators of fragmentation point to degradation of the high density mossy forest.

Table 7: Patch Metrics for 1990 and 2002

Class Name	**Number of Patches**		**Largest Patch Index**	
	1990	2002	1990	2002
High density mossy forest	1116	1194	5.47	2.68
Low density mixed forest	1243	892	3.71	7.35
Secondary grassland vegetation	1358	1160	0.29	0.99
Grassland	1390	1371	1.76	2.61
Agricultural lands	484	458	0.53	0.28
Non-forest	414	222	0.22	0.07

Figure 13: Land Cover Maps of 1990 and 2002



Participatory Mapping

Mapping of the area was undertaken on field with several knowledgeable members of the community and through an actual investigation by other members of the community of the topographic maps and a satellite image.

On field, members of the local council of Tulgao West pointed out main landmarks within the domain and named them. Later, information from hunters who were able to read the map and a terrain model of the area were likewise collected. Boundaries in every corner were pointed out and lines were drawn to connect ridges and rivers, and the result was a domain map that showed a much bigger area than the political boundary of Tulgao.

Figure 14 shows the political map of Tulgao over portions of the joined topographic maps of Lubuagan and Sallapadan. Within and around the immediate vicinity of the political boundary were named features, like the mountain peaks of Mosimus, Bangbanglang, Mauban, Alchan and Cauitan, and the Pasil River.

Meanwhile, Figure 15 shows the political map and the drawn domain map against the backdrop of the 2002 satellite image. Many natural features marking the Tulgao domain have been identified by the participants. Creeks, mountain passes and ridges were named based on a long history of actual resource access, control and use. In areas that the informants have not themselves fully explored, information came from elders who can substantiate their claims also through stories of actual access and use from long ago. Figure 16 is a terrain model to emphasize how boundaries were decided then.

Tulgao ancestral domain

As in many traditional communities in Kalinga and other parts of the Cordillera uplands, domain boundaries were clear among the Tulgao people and their neighbors. These were formalized in their peace pacts, forged through highly ritualized steps, thus considered sacred agreements. Later, even when peace pacts were supported by written and signed documents between two communities, domain boundaries were still described in general terms and many details such as names of creeks and ridges as markers of many corners remained in the minds of the people.

Today, new policies that apply to resources, new goals of some community members and the presence of outside players with interest in the resources within the domain are threatening Tulgao. Similar to other communities, the imposition of a formal system that required "drawing lines" between political units made informal arrangements problematic for indigenous communities. Another complicating circumstance is changing goals. Before, people used resources for subsistence, but today, the inevitable participation of the people in a cash economy have changed the views of some members of the community on resource use.

Participation in research

Participatory mapping was embedded in this research through the field exercises and actual reading of the maps and a satellite image to mark the metes and bounds of the domain. One of the most significant outputs of the participatory mapping exercises was a Tulgao map larger than the political map. Place names were likewise added to sparsely-labeled old topographic maps.

Participation in domain mapping was limited to the provision of information and mostly by men. Many of these informants know the forests because of activities like hunting, guiding tourists and gathering forest products. They have likewise used trails established a long time ago to get to other communities, like Sagada, Abra, other parts of Tinglayan and the municipalities of Lubuagan and Pasil. Women, on the other hand, do not do normally hunt or guide tourists and generally perform their roles in agriculture in areas closer to the settlement.

Men likewise participated in other aspects of the research and were instrumental in various essential decisions. They aided in the identification and clarification of the research problem (discussed in the introductory portion of this report), and they decided on the extent and composition of community counterpart for field work and the selection of sites for data collection.

Clarification of research problem

The research was carried out to assist the community catalog its natural resources. This has become important in view of many attempts to implement development projects in the area by outsiders, and the community's realization that it needs actual written data in protecting their domain and if necessary, for negotiation.

Over the years, the local community of Tulgao has collectively refused the entry of corporate mining in the area. Recent attempts of outsiders for mining exploration have failed. Dialogues were held to acquire community consent, but the community steadfastly refused to cooperate in the light of unclear responses to their queries and unimpressed by promises of future material gains in the widespread exploitation of their resources. The village leader of Tulgao West cited the following for their rejection of the most recent (March 2007) request to explore their area:

1) The mining company presented a plan on what to do in the area without due consideration of the plans and goals of the community in regard to the use of its resources;

2) For discussion, the community had asked what compensation awaits the people if they will allow their lands to be explored for mining. The mining company failed to provide a response that was satisfactory for the community;

3) The people know that their lands are acidic, and were told that in the exploration, water will be required during drilling. The community fears that water will be diverted for this purpose and deprive them of the resource;

4) However friendly the arrangements being offered, the community is convinced that the mining company will fence them out of the area to be explored, thus further detaching them from the management of their lands;

5) If exploration and mining will be allowed, conflicts will arise if some people will receive better compensation than others; or if outsiders will be employed and not community members. Many will join the insurgency movement and the government will bring in the military, possibly turning a once peaceful community into a community of unrest.

Composition and extent of community participation

Local leaders, municipal employees, hunters, elders, young men and women provided support to the research, from the initial planning of the fieldwork, to the process of obtaining consent for the research, in site selection and until the actual data gathering in the field. The support was not limited to hauling supplies but also in obtaining GPS points (by those who participated in the December training), to the collection of specimens and the processing of these while on field, in the identification of common names of the collected flora specimens to the identification of important places (or *dissu*) in their domain.

This study showed that the people of Tulgao will participate in any activity that they believe will benefit them, thus their willingness to participate in the mapping and survey of their domain. The local leadership acknowledges the necessity of keeping up with the changing times. To sustain control over their domain and resources and to equip themselves well for future negotiations, they are now seeing the need to inventory their resources and codify them. Written documents as proof of ownership have become the norm and the community of Tulgao, in its goal to maintain control over its domain, has responded to this challenge, thus our relative success in producing this research output with their full support.

Figure 14: Political Boundary of Tulgao over a 1:50,000 Topographic Map

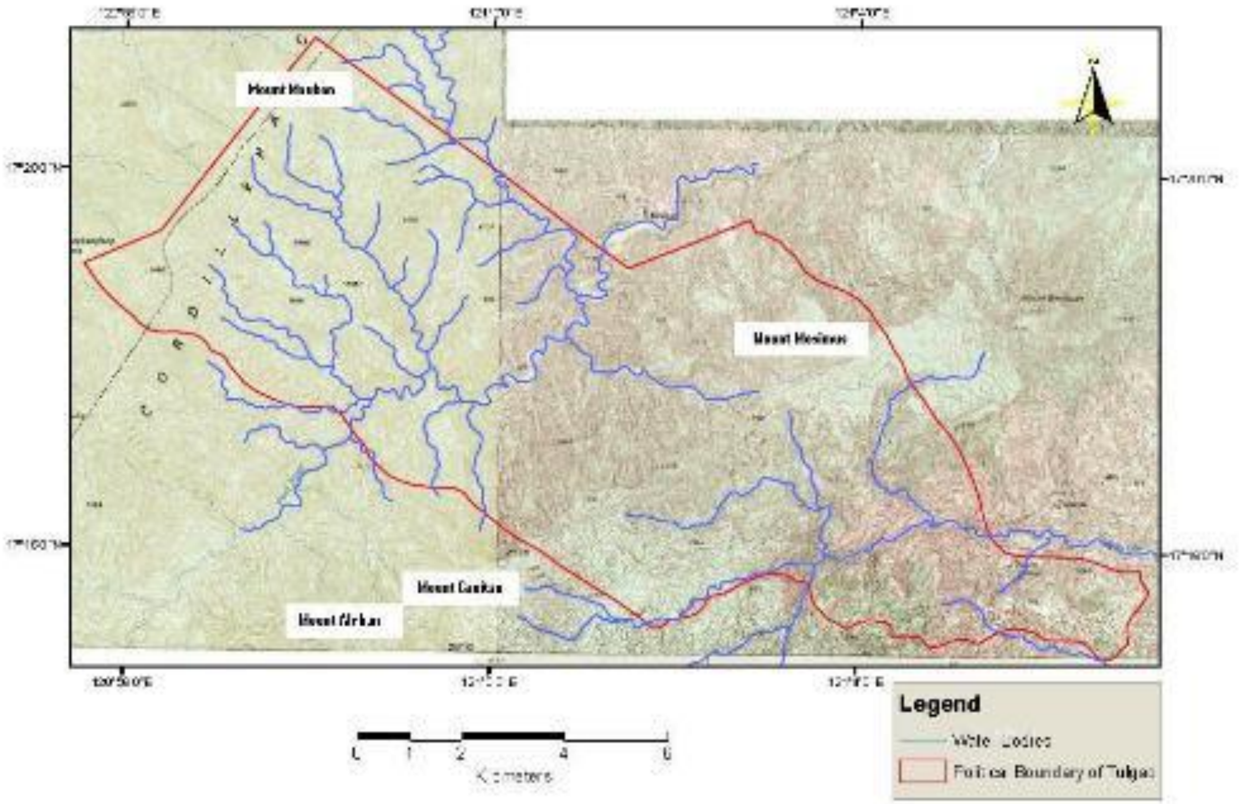
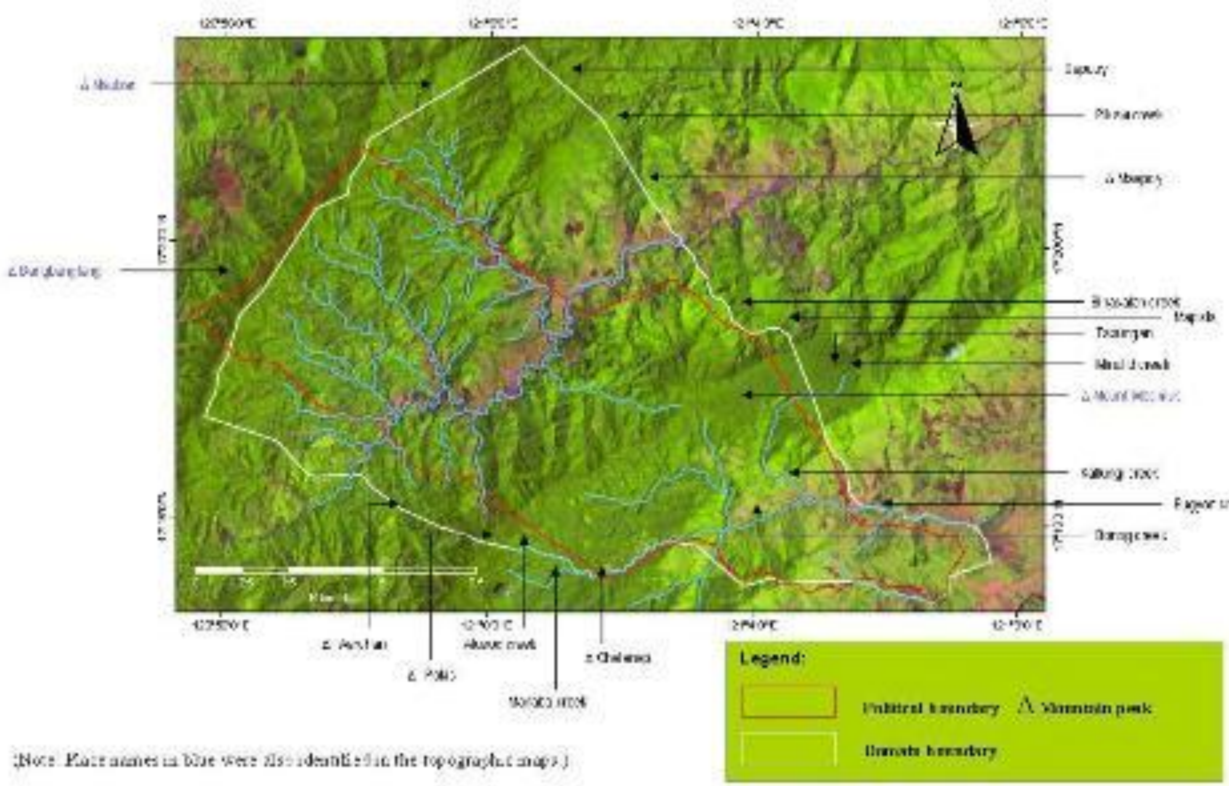
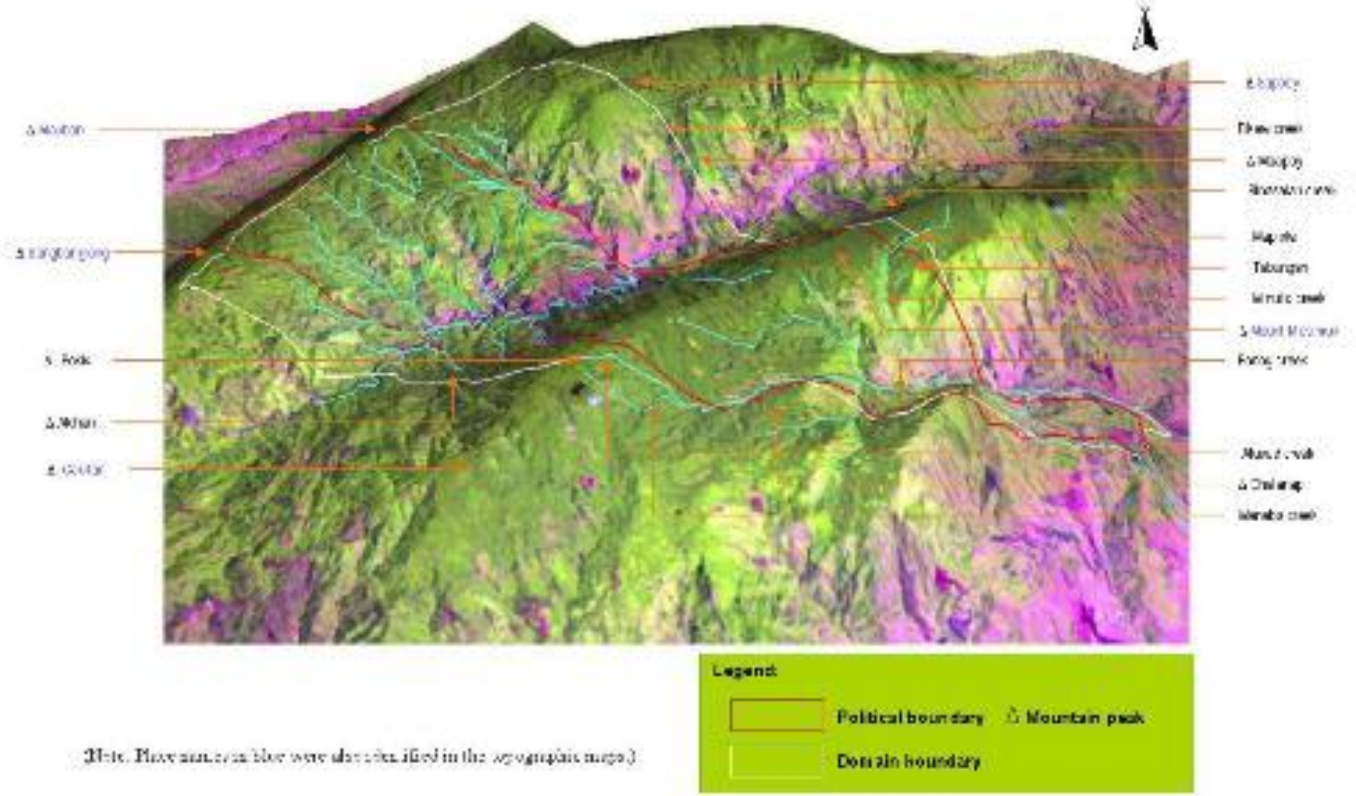


Figure 15: Political Map and Domain Map over the April 3, 2002 Landsat ETM+ Image



(Note: Place names in blue were also identified in the topographic maps.)

Figure 16: Political Map and Domain Map over a Terrain Model from the April 3, 2002 Landsat ETM+ Image



CONCLUSION AND RECOMMENDATIONS

Like other montane forests of the Cordillera, it is observed that the primary threat to the biodiversity of Tulgao is land conversion. The research site was heavily disturbed by human activity (e.g. clearing of forests to give way to vegetable gardens) resulting to forest gaps of variable sizes. However, even with the fragmentation that was observed in the area, and despite the limited scope covered in the field sites, the results of this initial study show a rich and diverse ecosystem that help sustain the activities of the people in and around Tulgao, and nearby communities. This initially confirms the classification of Tinglayan by the PBCPP (2002) as an area with extremely important terrestrial and inland water biodiversity resources. Specific recommendations have been formulated based on the results of each of the components of this research.

Geophysical Features

• Faults, folds and other geologic features (tributaries, volcanic cones and the like) need to be delineated in the area. As an initial step, it is suggested to obtain pertinent aerial photographs from where initial interpretations can be based.

• More detailed surface drainage features, together with the topography, need to be interpreted and digitized. This could serve as the base map for various attributes of the study area.

• Petrographic study of rocks in thin sections is necessary to verify the nature of volcanism and possible precious metal mineralization in the area.

Fauna

• The team only sampled a patch of abandoned agricultural area within 1700 masl to 1900 masl elevations and was not able to sample the thickest, undisturbed portions of the area at the same elevations. It is therefore recommended that another trapping be done in an undisturbed location to acquire a better estimate of the actual number of species of murids at that elevation. Standard elevation mapping done in the Cordillera showed that there are more than 10 Genus of murids at such elevation.

• The assessment on species of bat was also incomplete. The standard trapping method for flying mammals must then be conducted specially in an undisturbed portion of the forest.

Flora

• The team did the collection in a very limited area, but already, the diversity of specimens collected seem to be comparable to two other important montane forests in the region, namely Mt. Sto. Tomas and Mt. Data. It is recommended that further collection be made in the undisturbed forest, especially inside Mt. Mosimus.

Microbiology

• It is recommended that the possible identification of these bacteria isolated in this present study should further be confirmed by more biochemical and microscopic analyses or identification kits. But the possible Genus of bacteria suggests that the isolates found in the soil samples were common parasites of humans. For instance, the gram positive cocci staphylococci occasionally cause serious human infections. *Neisseria* sp. are commonly isolated from animals and some species may also be pathogenic. The oxidase negative and gram negative cocci (Isolate No. 10) could possibly belong to the Genus *Acinetobacter* which are common soil and water organisms although they are occasionally found as parasites of certain animals and have been implicated in nosocomial infections. The gram negative rods with fermentative metabolism could belong to the *Vibrio* group, which were found in sites 1, 2 and 3. Most *Vibrios* are aquatic organisms either in freshwater and marine habitats. They were isolated from the river and river basins in this study. These organism can also be pathogenic to humans for example one species, *Vibrio cholera* is the bacterium that specifically causes cholera, one of the most common infectious human diseases that is transmitted exclusively via water (Madigan, Martinko and Parker, 1997).

• It may not be conclusive, but according to the Comprehensive Land Use Plan (CLUP, 2004) of Tinglayan, the leading causes of morbidity in the municipality from 1998 to 2000 are diarrhea, bronchitis and influenza; while the leading causes of mortality are pneumonia, pulmonary tuberculosis and diarrhea. The bacteria we have isolated in this study that were found from various soil samples (both in terrestrial and water habitats) in the six locations around Tinglayan may explain why these are the common diseases in the Municipality of Tinglayan.

Mapping

• The Tulgao domain map drawn from the mapping exercises is not final. For it to be useful, it needs to be presented for validation, first to a larger number of community members in Tulgao and second, to knowledgeable community representatives from the villages that share boundaries with Tulgao. These are necessary future steps especially since literally "drawing boundary lines" is not part of the Kalinga people's mapping tradition.

FPIC Process

This research started with a perceived weakness in the FPIC process, with critique on the conduct and questions on the integrity of the Environmental and Social Impact Assessment (ESIA). The major question on the process has to do with the independence of bodies that conduct the ESIA. Another criticism, as in the case of the Geothermal Project in Kalinga, is the failure of conducting an ESIA first before holding the FPIC.

This study may be seen as an initial ESIA that can be used by the Tulgao communities, relevant agencies and government bodies before deciding on the Geothermal project. This study is by no means complete. It is critical that Mt. Mosimus and Mt. Binulauan be further studied systematically to identify threats to biodiversity and sustainable development. Once this is done, the ESIA may be continued to monitor changes in the ecosystem brought about by both natural causes and human activity.

Further Research and Local Capability Building

Safeguarding the integrity of the ecosystem in Tinglayan requires a variety of strategies. As stated earlier, further biodiversity research is needed in the area to cover important watershed and forest resources that include Mt. Mosimus and Mt. Binulauan. Another strategy should include local capability building, where a select group of residents (barangay leaders, teachers, high school or college students, for example) may be identified and trained for measuring certain attributes (e.g. rainfall, air and water temperature, water discharge at periodic intervals), proper collection of flora and fauna, and other environmental data. The team believes that this will encourage community participation in the monitoring and conservation of biodiversity resources in Tinglayan, especially if the ESIA has to continue.

The ecosystem is critical to the survival of the community as it provides basic necessities such as food, water and medicines. It is integral to the environmental, cultural, spiritual, recreational and intellectual well-being of the people. While it may be true that the ecosystem is “self regulating” and resilient in that it is capable of returning back to its equilibrium state after a disturbance, disturbances beyond its capacity to adapt will result to a chaotic state. It would be difficult to predict when an ecosystem stabilizes after such disturbances, owing to inherent complex interactions inherent within the system.

Major development projects in the research area might irreparably damage vital ecosystems. Together with the Tulgao people, it is best for the local government to weigh such plans carefully, and to arrive at decisions that are supported by research, sensitive to the sentiment of the communities, and adhere to principles of sustainability for the sake of future generation.

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MAPS

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NAMRIA, n.d. 1:50:000 Topographic map Sheet 7177 I

NAMRIA, n.d. 1:50:000 Topographic map Sheet 7277 IV

APPENDIX A: SELECTED IMAGES OF COLLECTED FAUNA

RODENTS

Figure A.1 *Apomys abrae*

Figure A.2 *Chrotomys whiteheadii*

Figure A.3 *Rattus everetii*

Figure A.4 *Rattus exulans*

BAT

Figure A.5 *Otopteropus cartilagonodus*

BIRDS

Figure A.6 *Pachycephala albiventris*

Figure A.7 *Rhipidura cyaniceps*

Figure A.8 *Spilornis cheela* or crested serpent eagle

Figure A.9 *Lanius cristatus*

Figure A.10 *P. Marchei*

DEER

Figure A.11 *Cervus marianus*

APPENDIX B: SELECTED IMAGES OF COLLECTED FLORA

Figure B.1. Arisaema sp., Araceae

Figure B.2. *Medinilla* sp, Melastomataceae

Figure B.3. Elastotema sp., Urticaceae

Figure B.4. *Cephalomanes apiifolia*, Hymenophyllaceae

Figure B.5. Begonia sp., Begoniaceae

Figure B.6. *Melastoma* sp., Melastomataceae

Figure B.7. *Microsorium* sp., Polypodiaceae

APPENDIX C: PHOTO DOCUMENTATION

Visit to the Local Chief Executive of Tinglayan, December 6, 2007

GPS Training, December 27 and 28, 2007

Reconnaissance and Community Consultations






Fieldwork in April 2008









 

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